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Technical Report N° 17

E R G O N O M I C S I N P E R S O N N E L P L A N N I N G

Source : Ergonomic Team of the German iron and steel industry
Project N° 1

Authors : R. HACKSTEIN, F. von BELOW, E. GÜTTLER, G.A. KOCH, F.W. MEYER, C.A. ROOS

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ERGONOMICS IN PERSONNEL PLANNING

Source : Ergonomic Team of the German iron and steel industry
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Preface

One of the most important tasks of industrial personnel management at present is to develop and apply practicable personnel planning methods. Research workers must therefore cooperate with staff engaged in practical personnel work in order to develop such planning methods and prepare them for operational use. The fact that such methods are required is reflected very clearly in the difficulty of recruiting staff which has existed now for many years and has hitherto largely been solved by improvisation and ad hoc measures to suit the individual circumstances. This situation is mainly due to the lack of forward-looking personnel planning.

The fact that personnel planning lags behind planning in other sectors of management is no doubt due in large measure to the lack of the initial and future data necessary for personnel planning. Research in this sector must therefore consider the methodological questions of practical data acquisition and utilization and build practically applicable planning models.

In the Iron and Steel Industry it appeared particularly important and urgent to meet these requirements because of far-reaching technical and organizational changes and corresponding influences on job definitions and job requirements. The need was felt to provide instruments for short and longer term personnel planning while at the same time integrating ergonomics - moving beyond the stage of isolated measures - into personnel planning.

This view was shared by the Wirtschaftsvereinigung Eisen- und Stahlindustrie (Iron and Steel Industry Association), the boards of a number of member enterprises and the Forschungsinstitut für Rationalisierung (Research Institute for Rationalisation) at the RWTH Aachen. A joint research project

entitled "Development of a method for analyzing present and future job requirement and aptitude profiles taking into account special job grades as a basis for a personnel information system" was outlined and an application for a subsidy submitted to the Commission of the European Communities (CEC) as the first sub-project of a two-part general project for the sector of industrial workers. The aim of the second sub-project, in respect of which an application for a subsidy was submitted to the CEC in March 1973, is to provide the instruments for long-term personnel planning and its integration into enterprise planning in order to ensure - in the context of advancing mechanization and automation, further technical and organizational development and changes in production programmes - timely and active adaptation of techniques to man through the ergonomic design of working activities.

The CEC agreed to provide financial assistance representing 70 % of the estimated cost of the first sub-project; the following nine enterprises in the German Iron and Steel Industry, listed in alphabetical order, expressed a readiness to give the project their active support by providing staff and materials :

August-Thyssen-Hütte AG
Eisenwerk-Gesellschaft Maximilianshütte mbH
Hoesch-Hüttenwerke AG
Mannesmann AG Hüttenwerke
Rheinstahl Hüttenwerke AG Henrichshütte
Stahlwerke Peine-Salzgitter AG
Stahlwerke Röchling-Burbach GmbH
Stahlwerke Südwestfalen AG
Thyssen-Niederrhein AG.

The Forschungsinstitut für Rationalisierung (FIR) (Research Institute for Rationalisation) at Aachen Technical University undertook responsibility for carrying out the studies. The research covered the period of two years stipulated in the subsidy application, beginning on 1 November 1971.

The FIR Research Group was backed by a project council made up of leading experts from the Iron and Steel Industry with one Employees' Representative Director as Chairman and Deputy-Chairman. The formation of this Council proved very important and useful; the Council gave valuable assistance in ensuring that the instruments used in the study were both technically correct and practically feasible. At its plenary meetings and in special discussions with the Council members representing specific disciplines - industrial medicine, industrial and operational psychology, training and ergonomics - fundamental and methodological questions could always be clarified in good time, thus avoiding unnecessary work and errors. The members of the project Council were :

G.W. H a g n e r,
until 30.6.1973, Employees' Representative on the
Board of Rheinstahl Hüttenwerke AG
Chairman of the project Council until 24 May 1973

W. H e n n e,
Employees' Representative on the Board of Mannesmann AG
Hüttenwerke, Deputy-Chairman, Chairman since 24 May 1973

Dipl. Psych. H. F i s c h e r,
Head of the Industrial Psychology Department of
Mannesmann AG Hüttenwerke

H.G. H e i d b e r g,
Employees' Representative on the Board of Stahlwerke
Peine-Salzgitter AG
Member of project Council until 10.10.1972

Prof. Dr. med. Th. H e t t i n g e r,
Industrial physician at Rheinstahl AG
- Bau- und Wärmetechnik -

R. J u d i t h,
Member of the Board of the Industriegewerkschaft Metall
(Metal Industry Trade Union)

E. N e u m a n n,
Training Manager at Stahlwerke
Peine-Salzgitter AG

Dr. med. E. R e i n e r,
Head of Health Department at
Mannesmann AG Hüttenwerke

Dr. Ing. B. S c h n e i d e r,
Head of Personnel Organization Department at
Mannesmannröhren-Werke AG

Dir. R. S c h r e i n e r,
Head of Personnel Management Department at
Mannesmann AG Hüttenwerke

Dr. G. S i e b e r,
Employees' Representative on the Board of
Hoesch Hüttenwerke AG,
Member of project Council from 13.10.1972

Dir. H. H a r t m a n n,
Employment and Social Management Department of
the Wirtschaftsvereinigung Eisen- und Stahlindustrie
(Iron and Steel Industry Association)

The nine enterprises referred to previously agreed to define the research project in the light of their immediate interests and practical possibilities, in discussions lasting for several days between experts from the works and the FIR research group insight into the specific working conditions, assisting in the choice and delimitation of appropriate study areas and preparing and making available meaningful material for the research. On the basis of these intensive preliminary studies and the expert knowledge of the Council members, four research areas typical of the iron and steel industry were later chosen jointly with the project Council and field studies lasting for several weeks conducted in each of them.

We wish to express our warm appreciation to all the institutions, works and individuals mentioned above. Our thanks are due to the CEC for its financial support, to the Wirtschaftsvereinigung Eisen- und Stahlindustrie for its unflagging and intensive effort to bring the project into being, to the enterprises - in particular those in which extended research was carried out - for defraying the costs incurred and providing a great deal of non-material aid, to the Chairman and members of the project Council and to all other expert advisers for their willing and complete cooperation.

1. INTRODUCTION AND DEFINITION OF THE PROBLEM

1.1 Tasks of personnel planning

Our study - the procedure and results of which are outlined in the following report - was based on the workplaces and activities of highly skilled workers employed in the Iron and Steel Industry.

The studies were, however, designed from the outset to allow subsequent extension - in certain cases even immediate application - of the instruments developed to workers covered by the Collective Wage Agreements. Personnel planning effected with instruments of this kind can only be fully effective if it is not confined to skilled workers but also covers other categories of employees. Moreover, the determination of the aptitudes of skilled workers must also indicate whether and to what extent they are capable of taking over more senior activities, e.g. when staff are selected for training for supervisory positions. Finally, in the Iron and Steel Industry, there are several sectors in which supervisory activities are so closely linked to the activities of skilled workers that it seemed desirable to include certain supervisory activities in our research. The basic limitation to skilled workers must be considered provisional and was only decided with a view to obtaining meaningful results while holding the research within practicable bounds.

Before designing the research project, it was necessary to define what is meant by "personnel planning" and what is expected of it. As an initial consideration, personnel planning must be oriented towards the main tasks

of industrial personnel management and also towards the sequence of actions in achieving practical industrial aims (see KOCH 37[1]).

The task of industrial personnel management consists in making available to the enterprise the requisite number of employees with adequate qualifications to achieve a given performance programme at the correct time. Personnel management also has the no less important tasks of taking account as far as possible of the personal interests of the individual members of staff, since the first aim can only be successively achieved in the long-term if the personal interests of the individual largely coincide with the interests of the enterprise. This means that for the "performance community" brought together in an enterprise, it is important to achieve the closest possible concordance between the individual performance necessary to achieve the operational target and the individual's requirement for self-development and self-fulfilment.

In this sense, the task of industrial personnel management may be defined as follows, with BELLINGER (1) :

"The task of industrial personnel management is to make available the necessary human work capacity to achieve the industrial target while safeguarding the rights and as far as possible taking into account the needs of individual staff members."

Since a wide range of different measures are generally necessary to make the human work capacity available, HACKSTEIN/NÜSSGENS/UPHUS (22) divide the tasks of industrial personnel management into the following functional

1) Details of sources will be found in the bibliography at the end of this report.

sectors : determining personnel requirements, recruiting personnel, developing personnel, utilizing personnel, retaining personnel, releasing personnel. Using different criteria and approaches, other authors arrive at other classifications which all generally contain the categories of determining personnel requirements, recruiting, developing and utilizing staff (see e.g. GAUGLER/HUBER 17 and FITTING/AUFFARTH 14).

There is therefore a broad unanimity of views as to these four focal points of industrial personnel management. The following reasons militate in favour of adding the "retaining and releasing personnel" categories :

The retention of personnel is acquiring increasing importance in the context of industrial personnel management. Staff must be able and willing to work and this heading involves above all the medical and social services of the enterprise, industrial safety and job structuring as important tasks for industrial personnel management with a view to satisfying justified requirements of personnel and adapting work to man.

The release of personnel can of course be considered logically to complement the recruitment function; however, the tasks and measures involved in releasing personnel differ fundamentally from those of recruitment. This becomes clear when large-scale redundancies are considered, e.g. when plants are closed down. The complexity of the measures to be taken in such cases makes it necessary to include the release of personnel as a separate category in the functional classification of the tasks of industrial personnel management.

Against this background we arrive at the following functional classification of the tasks of industrial personnel management - based on the proposal made by HACKSTEIN/NUSSGENS/UPHUS (23) :

determining personnel requirements
recruiting personnel
developing personnel
utilizing personnel
retaining personnel
releasing personnel.

All industrial processes are implemented by a closed sequence of actions. In principle this also holds good for the performance contribution of industrial personnel management which was outlined above by defining its tasks. The industrial action sequence can be sub-divided into the following phases, again according to HACKSTEIN/NUSSGENS/UPHUS (23) :

planning
decision
acceptance
implementation
verification.

If these phases of the action sequence are applied to the performance of the individual functions of industrial personnel management, a noticeable qualitative difference emerges between the determination of personnel requirements and the other sub-functions. While the work of ascertaining personnel requirements is directed towards the calculation of future personnel capacity needs by specific methods and procedures, i.e. only indirectly concerned with individuals, the other sub-functions directly

concern groups or individuals. This difference arises from the fact that in the context of industrial personnel management the determination of personnel requirements is primarily an aim-setting function while the other functions mainly involve the implementation of aims. Personnel planning as forward-looking action preparation for industrial personnel management therefore includes the setting of aims and planning the implementation of those aims. The following diagram (figure 1) shows in simplified form the relationship between enterprise planning, personnel management and personnel planning (KOCH 37, page 268).

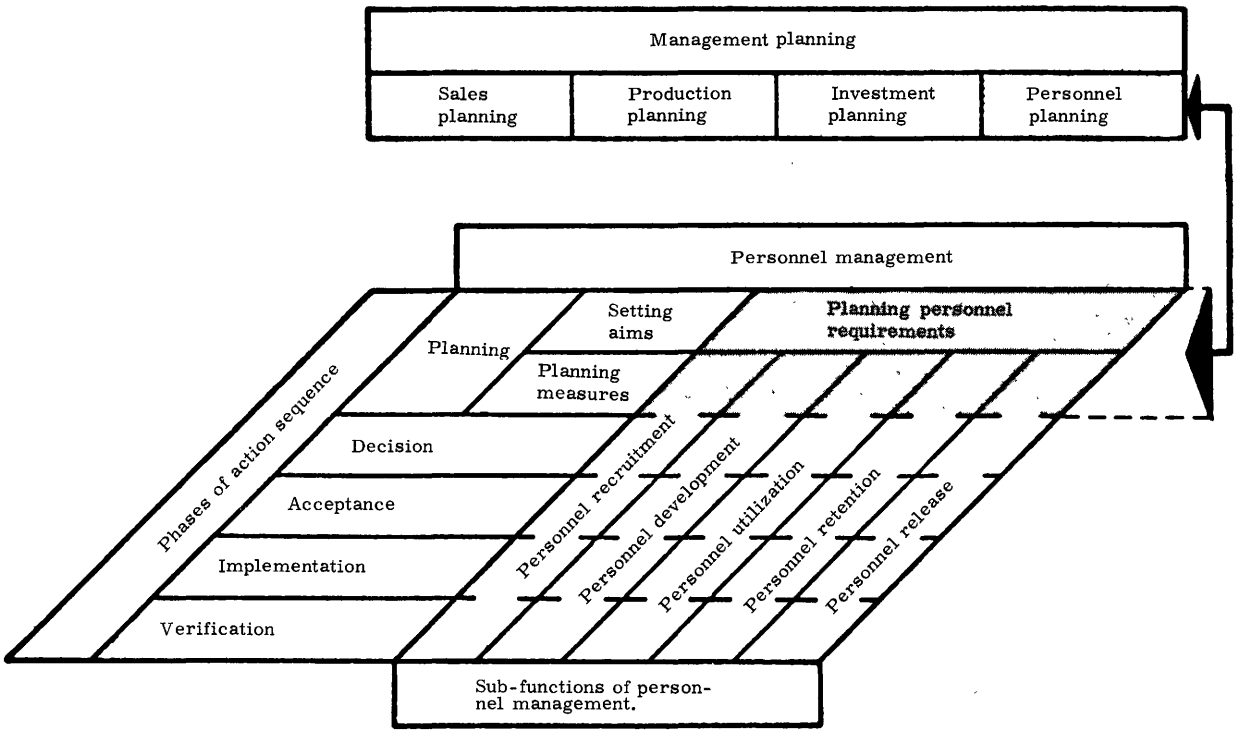

Fig. 1 : Personnel planning in the context of management planning and industrial personnel management

The figure shows that personnel planning covers a self-contained area of the matrix determined by the sub-functions of personnel management and the phases of the action sequence. It embraces the entire process of personnel requirement planning and the planning phases of all subsequent sub-functions.

The following definition of the concept of personnel planning can be deduced from the above observations :

"Personnel planning is a future-orientated action preparation to solve the tasks of industrial personnel management. On the one hand it sets the aims of personnel requirement planning while on the other preparing the measures necessary for personnel recruitment, personnel development, personnel utilization, personnel retention and personnel release" (KOCH 37, page 268).

The content of this definition shows that a great deal of data, both internal and external to the enterprise, must be available to solve the tasks of industrial personnel management and in particular of personnel planning. Consideration of the time horizons of industrial personnel planning makes this particularly clear. For the iron and steel industry the following approximate planning horizons apply to personnel planning as a function of the duration of the production and investment programmes :

- Short-term personnel planning (up to one year) with close reference to the immediate production planning in order to lay down appropriate establishment plans for the present and immediate future so as to use the available personnel as flexibly as possible.

- Medium-term personnel planning (up to three to five years) with close reference to investment planning in order to ascertain changes

in the necessary personnel requirements or available staff potential.

- Long-term personnel planning as a forecast going beyond the medium-term time horizon and making longer term allowance for enterprise and personnel policy safeguard measures.

In principle, the specific tasks of short-, medium- and long-term personnel planning must be considered jointly. To avoid conflict with medium-term planning, the medium-term consequences must also be taken into account when short-term requirements are ascertained and covered. Similarly, personnel policy based on long-term planning (e.g. internal training and promotion policy) must be defined with reference to the short- and medium-term requirements or potential.

Personnel planning necessarily influences the working career of staff. Even if it is primarily concerned with whole groups or categories of staff, it also has an indirect effect on individuals. This is not an objection to personnel planning; on the contrary, personnel planning is both desirable and necessary from the standpoint of enterprise staff as a whole and of each individual. The alternative would be to leave the individual's working career largely to chance. Personnel planning should be aimed at preventing this in a positive manner for staff. The staff responsible for personnel planning must be fully aware of the responsibilities which rest with them.

A further important aspect resides in the inter-action between personnel planning and technical and organizational changes. In the German iron and steel industry, changes of this nature have occurred on a considerable scale in recent years. It is now no longer sufficient to prepare personnel

plans roughly divided according to function and to fill workplaces by ad hoc measures, in other words by passive reaction. If a timely and active response, allowing for human requirements, is to be given to future changes through appropriate personnel measures or ergonomic intervention in the technical and organizational conditions, appropriate and meaningful workplace and personnel data must be available. Before practicable models and methods for active personnel planning of this kind can be worked out, it is therefore necessary to determine the structure and content of the corresponding workplace and personnel data and also to develop the necessary instruments for the practical acquisition, storage and processing of this data.

1.2 Tasks of ergonomic workplace design

The instruments referred to above must enable detailed information to be obtained on the qualitative personnel requirements and the necessary personnel potential. From the standpoint of a future-oriented enterprise personnel policy it would, however, be wrong to consider the conditions existing or expected to arise on the requirements side simply as criteria which the occupant of a particular workplace must meet. This would imply the subordination of man to the dictates of an inflexible technology. An approach of that kind cannot be justified; in particular it conflicts with the aim of humanizing work. There already exist - not least because of technical and social developments - requirements which can no longer be considered acceptable in human terms; these requirements must be changed - largely with the aid of technical means - by the planned adaptation of work to man. Preventive health protection in particular

requires the causes of influences which may in the short or long-term harm the health of staff, to be determined and removed by modifying the conditions of work and/or of the workplace. To eliminate such discrepancies, it may for example be necessary to eliminate load peaks which have an unfavourable effect on the physical balance of forces or unilateral loads which have similar consequences. In other cases, organizational measures with a long-term effect are indicated to avoid the occurrence of debilitating stress situations. If the division of labour has proceeded too far, often entailing unilateral loading, it will be desirable to humanize the working conditions by creating new and more versatile work structures. Without going into further criteria and possible solutions for the ergonomic design of workplaces - not least with a view to safeguarding health - it is clear that the information necessary for the definition and solution of ergonomic problems can only be acquired from a relevant comparison of requirements and aptitudes. If solutions for certain individual workplaces are not sufficient, only comprehensive comparisons of requirements and aptitudes can provide the basis for future ergonomic workplace design. The same comparisons, carried out with reference to specific questions determined in advance, will also help to achieve the target of health care in the enterprise.

In recent years, a large number of technical developments in the iron and steel industry and elsewhere, have led to far-reaching changes in job requirements. In many areas for example, the need for strenuous physical work has been reduced significantly. This means that at many workplaces technical development has considerably reduced the importance of requirements of this kind. However, it would not be appropriate to expect a further reduction in these demands from technical developments only, and it would not be justified to assume that the need for

requirement - aptitude comparison no longer applies at new workplaces involving nu strenuous physical work. Often rough comparisons suffice to show that these new workplaces involve requirements which call for modifications in the sense of more human work-structuring (allowing for technical and economic criteria).

This realization must be followed by carefully planned comparisons which alone enable the basic problem to be discovered behind the symptoms recognized to some extent by chance, and a solution to be found. An example will illustrate this point : in several sectors of the iron and steel industry new plants of such technical complexity have been commissioned recently that the works maintenance staff is often no longer able to remedy faults which arise. In such cases the enterprises must rely on the plant manufacturers' after-sales service which not infrequently involves relatively long down-times. The question is therefore increasingly arising as to whether it is possible and desirable in the long term to train internal maintenance staff as specialists for particular items of plant. In that case any absence of the relevant staff would have serious consequences for the enterprise. Against this background joint efforts are now being made by plant manufacturers and users to make new plants less sophisticated so that the faults can once again be remedied by the internal maintenance service. These efforts may have to be supplemented by training staff to acquire additional knowledge relating to a plant but not confined to one particular plant.

Job structuring in this sense must in future be an important component of industrial personnel planning if man is to be adapted to his work and above all work adapted to man. The instruments to be developed for personnel planning must therefore enable the data necessary for ergonomic job design to be acquired.

1.3 Aims of the project

The aims of the project are apparent from the tasks of industrial personnel planning and ergonomic job design outlined above. Since we consider ergonomic job design to be an indispensable component of industrial personnel planning, the aim of the project as a whole is to develop a model for short-, medium- and long-term personnel planning geared to the requirements of skilled workers in the iron and steel industry. This model must be at one and the same time sufficiently comprehensive and practical for operationally applicable methods and procedures for personnel requirement planning and personnel recruitment, development, utilization, retention and release planning as well as for ergonomic job design to be derived from it.

To achieve this end, a solution must be found to the following two sets of problems :

1) Industrial personnel planning must start out from the existing conditions. For this purpose, it is necessary to collate all the workplace and personnel data relevant to personnel planning; this data must then be arranged systematically and made available in such a way that it can be used for planning. For data or data groups which are not available in the enterprise or have only been measured inadequately, practical data acquisition instruments must be developed. The aim of this first programme is to define a data structure and the associated acquisition, storage and processing techniques in order - starting from the existing conditions - to visualize the longer term changes on the workplace and personnel side and in the short term area to work out the measures which are directly necessary, including health and general ergonomic measures on the workplace and personnel sides.

2) Personnel planning forms part of management planning. The aim of the second programme must therefore be to develop a self-contained model of industrial personnel planning coupled with management planning. This model must, on the one hand, cover the planning aspects of all sub-functions of industrial personnel management and, on the other, allow all the influence parameters which will act in the future on the workplace and personnel side to be adequately covered. On the workplace side, these influence parameters include the entire economic development and above all product changes, new technologies and technical and organizational variations. On the personnel side, developments in the tariff contract, social and educational policy areas must be considered, as well as various social policy changes.

The wide extent of both sets of problems has led to the division of the overall project into two parts as mentioned earlier. According to the first set of problems, the aim of the first sub-project reported on here, is to develop a practicable analytical method for characterizing job requirements on the one hand and the aptitude potential of skilled workers employed in the iron and steel industry on the other. These instruments should enable the operational situation on the workplace and personnel sides to be evaluated in differentiated terms at any time. Knowledge of the operational situation presented in this way is an indispensable prerequisite for the development and use of the personnel planning model worked out in the second sub-project.

The aim of the first sub-project therefore consists in working out a proposal for a workplace and personnel information system covering skilled workers in the iron and steel industry. To achieve this aim the following work phases were chosen and the results are reported below :

- Acquisition of a suitable method for comparison of requirements and aptitudes.

- Selection of a suitable method for comparison of requirements and aptitudes.

- Compilation of practically applicable methods of data acquisition.

- Design of an EDP-oriented workplace and personnel information system.

- Development of data evaluation programmes in the context of short-term personnel planning, oriented towards immediate problems.

- Data evaluation programmes for ergonomic work and workplace design with particular reference to health protection for personnel.

2. METHODS

2.1 Methodological requirements

In order to define a method of characterizing job requirements and aptitude potential it was first necessary to compile a catalogue of criteria with the aid of which the suitable method could be chosen. The fact that not all the requirements could be filled equally was expected from the outset so that for a proper assessment of the methods under discussion it was essential to determine the priority for meeting the individual criteria.

1) Uniformity of the method

Despite the two sets of problems to be studied, namely personnel planning and ergonomic workplace design which forms part of it, the aim was to arrive at the most uniform possible method. It was therefore necessary to overcome the difficulties arising from the different emphasis of analytical procedures relating to the problems of personnel planning on the one hand and to those of ergonomic workplace design on the other.

2) Practical applicability

The proposed use of the analysis method in a real situation led to the requirement for a high degree of practicability for the method as a whole and for its individual components as well as the peripheral conditions such as data acquisition and evaluation.

3) Clarity, consistency

The method had to be designed in terms of its structure, measuring and assessment procedures in such a way as to eliminate subjective influences as far as possible. Only when the analysis result is largely independent of the individuals studied can this requirement for clarity and reproducibility be considered to have been met.

4) Range of reference

In a comparison of requirements and aptitudes the reference system should not only be the individual workplace or worker; it should also be possible to analyze entire groups by assembling the individual results. This is an essential condition for planning purposes in particular.

5) Comparability of information

The information - subsequently contained in an information system - should allow the following comparisons according to JÄGER (32, page 624) :

- between requirement and aptitude characteristics. For this purpose identical information and evaluation methods must be used;

- between the individual characteristics under study in order to place the direct emphasis on the selected individual criteria. For this purpose a single calibration basis or similar or matched evaluation scales are needed;

- comparison on the one hand of the requirements and on the other of the aptitudes in order to determine clearly changes on both the sides.

6) Structure suitable for EDP

The large quantity of data required to check the method and above all the proposed later use in large enterprises both as an information system and also for planning purposes mean that it must be possible for all the data to be processed in an electronic data processing system. In principle, however, the method should also be applicable in small and medium-size enterprises, i.e. possibly without the use of EDP equipment.

2.2 Critical assessment of the existing methods in literature and practice

For workplace analysis which has long been carried out with different objectives a large number of methods have been developed, with a specific intention in mind in each case.

All the existing methods can be divided into the following approximate groups :

1) Analytical job evaluation methods, the main aim of which is to determine wages and salaries. The best known is certainly the method of EULER/ STEVENS (11) developed for skilled workplaces and activities in the iron and steel industry. The "requirement types" defined in that method were used to some extent in compiling the requirement and aptitude characteristics listed in chapter 3.3.4. The special feature of workplace analysis of this kind is that they are confined - quite sufficiently for this purpose - to a few requirement types which can be clearly delineated (Geneva scheme of 1950). The criterion adopted is the level of stress occurring depending on the type of requirement at the workplace. For other purposes the information obtained in this way is less meaningful as a critical examination shows.

2) Analytical methods which are used solely for ergonomic work and workplace design. For these analyses A. RÜSSEL (55, page 94) noted quite accurately that "the question must be clarified as to whether there is an optimal relationship between the expenditure of time, effort and mental stress and the yield. The results of the analysis carried out for this purpose must be "noted in realistic terms" (loc.cit.). For the purposes of our research project this means that a synthesis must be found which enables

the analysis method developed to be used also for ergonomic job design.

3) Methods which attempt to determine the suitability of applicants or staff members for specific workplaces, requirements (of the workplace) and aptitudes (of the staff) being compared.

In order to use the workplace analysis and corresponding analysis of staff aptitudes for personnel planning in the iron and steel industry, a critical appraisal had to be made of the methodological criteria available. The essential methods for comparing requirements and aptitudes referred to in literature and industrial practice are briefly outlined below.

Subjective aptitude assessment

This procedure advocated by many practitioners in industry (and only by them) is characterized by the fact that the decisions on the occupation of workplaces are always taken on the basis of an overall personal impression of the workplace and of the persons concerned. The advocates of this procedure which is rejected in literature for many reasons (see J. EYSENCK 12) believe that they can most reliably assess the complex factors involved by intuitive means. For personnel planning purposes, this method, quite apart from the sources of error noted by experts, is not suitable because it is only applicable to the employment situation at a specific point in time.

Unilateral analysis methods

In unilateral analysis methods an attempt is made to objectify the

decisions by considering certain quantifiable data. However, there is no comparison with the other side. In the case of unilateral procedures a distinction may be made between :

- Analysis of personnel data : this method, often used in large enterprises, is based on an evaluation of all the available personnel data - school reports, employment certificates, curriculum vitae etc. - after which a decision is reached in conjunction with appointment or transfer interviews.
  Finally, an examination is made by the works doctor and possibly also by the industrial psychologist in order to check the provisional decision from their points of view. However, the workplace requirements and conditions are not ascertained according to relevant parameters.

- Analysis of workplace data : in other enterprises a thorough analysis is made of the activities to be performed and the environmental conditions. This is done not only with a view to an expedient allocation of staff but often with the main aim of determining correct wages, delimiting decision and responsibility areas and defining possibilities of rationalization.

When this method is used for planning the utilization of personnel, the material compiled on the workplace to be filled is examined in order to formulate questions to the applicant. While therefore a relatively detailed analysis is made on the workplace side, the question as to whether the applicant or staff member is suited to the workplace is answered by a general assessment of his aptitudes.

Overall method

This method, which is also known in literature as overall diagnosis (see JÄGER 32, page 621), is characterized by the fact that a decision is reached on the basis of an overall personal impression of the workplace and the persons to be employed. Before a decision is taken on the utilization of staff, all available data on the workplace and personnel sides is considered. This data includes, e.g.

- on the personnel side : information contained in the personal records, application details, reports of superiors and
- on the workplace side : workplace or job descriptions, occupation patterns etc.

Despite these objectifying measures the decision eventually taken is based on experience and intuition because a direct comparison of the available data is generally not possible. However, since the available information sources are fully utilized, the probability of a correct personnel utilization decision is greater when the overall method is used than with the procedures described previously.

In the context of personnel planning - and certainly in all areas involving individual staff members - an overall intuitive assessment may provide useful additional information on all points which cannot be covered in the other methods. For example, in the method proposed in this report, the profile comparison is followed by consideration, before the final decision is taken, of criteria which are difficult to quantify such as personal wishes and requirements which can be assessed by this intuitive approach.

Mathematical - statistical methods

Differential industrial psychology has for a long time been searching

for methods to appraise the entire "man-working environment" system in quantitative terms and thus place the assessments of suitability on an objective, numerically sound basis. In order to avoid having to analyze all the technical and organizational conditions at a workplace in studies with this aim, mathematical-statistical procedures are used based on the criterion "working success". The working success can be determined by an objective or subjective method according to SCHMIDTKE and SCHMALE (57, page 31 and pages 43-46).

The objective method can only be used for workplaces where the quantity (e.g. number of workpieces per unit of time) and quality of work can be numerically determined. In many cases therefore the subjective method can be used in which the immediate superior assesses the job success of individuals in an interview. Since errors of assessment cannot be ruled out in this subjective assessment and this degree of uncertainty is well-known, an attempt is made to increase the accuracy of the results by comprehensive data material. The fact that the value of the multi-dimensional "job success" criterion is limited, is demonstrated by JÄGER (33, page 55) who shows how a superior may define one worker in an overall assessment as good because he performs good work and another as good because he is essential to the good atmosphere in the department. Because of this complex state of affairs, JÄGER considers that there is only a 0.3 - 0.6 correlation between the judgments of the individuals' superiors.

Even lower coefficients are indicated in study reports by other authors.

Once a group of successful workers has been defined on the basis of the most objective possible criteria, the abilities of these individuals can be analyzed in a subsequent study with the aid of test procedures and other methods. These will then provide guide values for the level of the requirements at the workplace concerned which have to be met as far as possible by future staff members.

These guide values are, however, inaccurate because certain aptitudes are further developed by years of practice in a particular activity. More accurate values are achieved if all the applicants for a particular job are subjected to an extensive examination over a longer period. If the persons studied are found to have done good work at a particular workplace after an adequate training period, mathematical-statistical methods can be used to determine both the prognostic validity (in terms of forecasting job success) of an individual study method and the guide values to be achieved.

A brief description is given below of some methods required for evaluation :

- Regression method

  This method which has been the most thoroughly developed for practical purposes is based on the assumption that there are several features whose low development can be compensated by the high development of others. The resulting individual regression equation - which however requires a relatively complex study and calculation - shows whether job success is probable or improbable. In principle this method is quite suitable for planning purposes. As against the profile comparison described in chapter 2.3 below it has the advantage of allowing for the possibility of one type of requirement being compensated by another.

  This method does, however, have the following disadvantages :

  - minimum requirements which cannot be compensated are not shown
  - the job success criterion is imprecise
  - application of the method is very complicated and
  - it is not easy to understand for assessors who have little mathematical training and above all for the persons assessed.

- Method of lower norm values

  The aim of this method (SCHMALE 56, page 157) is to compare the results of the study of individuals who achieve a just adequate level of job success with the results of persons who are unseccessful. The lower norm value can then be derived.

- Centour method

In this method suggested by P.J. RULON (54) the study results of an individual are taken as vectors which correlate through Centour values with the results of a group of proven workers again taken as vectors. JANKE (34) defines these correlation coefficients as probabilities which indicate the similarity of a person with a group, i.e. the individual is classified under the group of positively assessed workers to which he best corresponds. Because the calculations allow for the mean value and dispersion, the information provided by this method is more accurate than in the two other mathematical-statistical methods (see SCHMALE 56, page 158f). However, with this method a maximum of only three test results can be considered in the calculation. The generally much larger number of results for an individual must therefore first be reduced with the aid of factor or discriminance analysis. The complex calculations which this method entails militate seriously against its practical applicability.

Combined method

The American expert R.B. CATTELL (5), following on from the work of J. KING, has developed a method which combines the profile method described in chapter 2.3 with the regression method. The effects of each individual feature for success in a job or activity are ascertained. The workplace-related weighting factors determined by this procedure are entered on a matrix. A clear definition of the aptitude of the applicant is then obtained. The combined method is, however, so complex that its practical application in the iron and steel industry does not seem possible.

2.3 Profile comparison as the selected method

A comparative study of the methods outlined in chapter 2.2 from the angles of :

- practicability
- validity
- clarity

showed that - from the angle of systematic personnel planning in the practical industrial situation - these methods do not meet the set requirements. The following deficiencies of the individual methods were decisive in arriving at this conclusion :

- Subjective aptitude assessment, unilateral analysis method :
  objective inadequacy.

- Mathematical-statistical method, combined method :
  mathematically too demanding and too complex for practical purposes.

- Overall method :
  inadequate validity, too little objectivity; however, the procedure adopted in this method and the information it gives may usefully complement other methods.

The profile comparison method is compared below with the above methods.

On the requirement side, a requirement profile is compiled for each workplace - understood both as a place of work fixed at a given point in space and as the area of activity of an individual; the structure of this profile enables all the workplaces occurring in the enterprise to be evaluated by a uniform scheme. The profile consists of a series of different requirement criteria occurring at the workplaces. The choice is made in terms which are relevant to the required aptitudes of the individual which can be ascertained with sufficient objectivity. Stages are defined for each characteristic in order to assess the requirement level in the individual case.

The aptitude profile of each staff member or applicant to be compared with the requirement profile is structured in the same way. It is divided into aptitude characteristics defined in such a way that a comparative association with the corresponding requirement features is possible. A specific range in the level of a corresponding aptitude feature can therefore be attributed to the requirement stage of each feature.

The basic procedure can be clarified by comparing the operational sequence in the profile method and method of the lower norm values (figure 2).

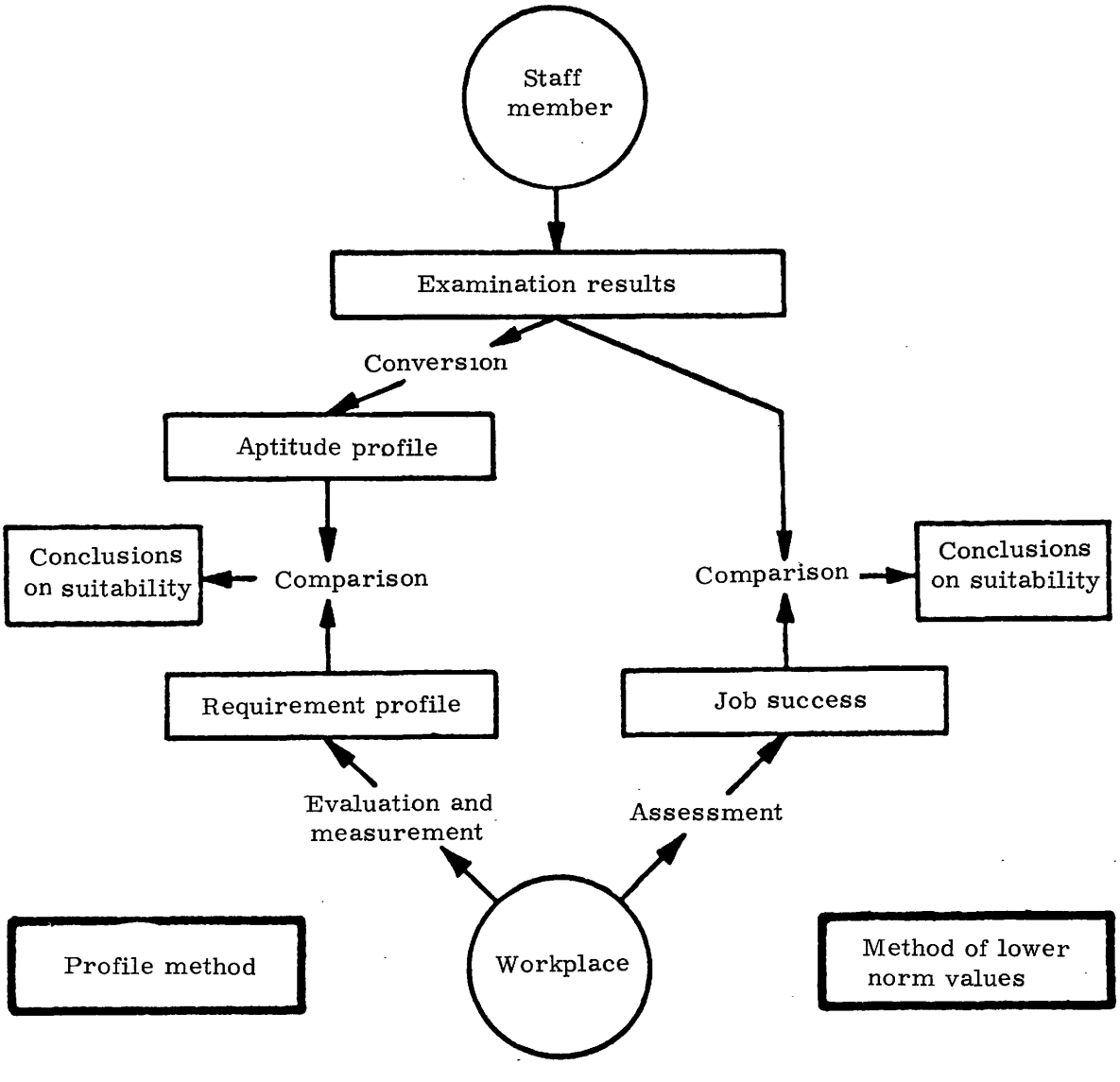

Fig. 2 : Differences between procedures in the profile method and method of lower norm values.

In the method of the lower norm values an attempt is made to establish a direct relationship between the job success and results of activity-relevant study methods. A number of sources of error can be excluded by this direct link; however, since on the workplace side only one single criteria, job success, is assessed (generally subjectively) by the immediate superior - no assessment of technical and organizational factors at the workplace being made - the method of lower norm values is based on less sure ground. In addition all the values are invalidated as soon as a slight change occurs at the workplace, i.e. the method offers no possibility of converting a job condition into correspondingly corrected study results.

On the other hand the profile method compares a number of criteria before reaching conclusions on suitability.

The following advantages of the profile comparison appear conclusive :

- It allows a direct comparison between the requirements of a workplace and the aptitudes of an individual.

- By means of a comparative graphic presentation of the profiles, congruence, overlapping and underlapping can be shown clearly (see figure 3).

- Instead of a largely subjective assessment of job success, the workplace requirements are either determined by measurement or estimated consistently with the aid of evaluation scales.

- The changes in requirements brought about at workplaces by technical and/or organizational changes (addition or removal of characteristics, changed requirement classification) can easily be incorporated into the requirement profile with reference to the features concerned.

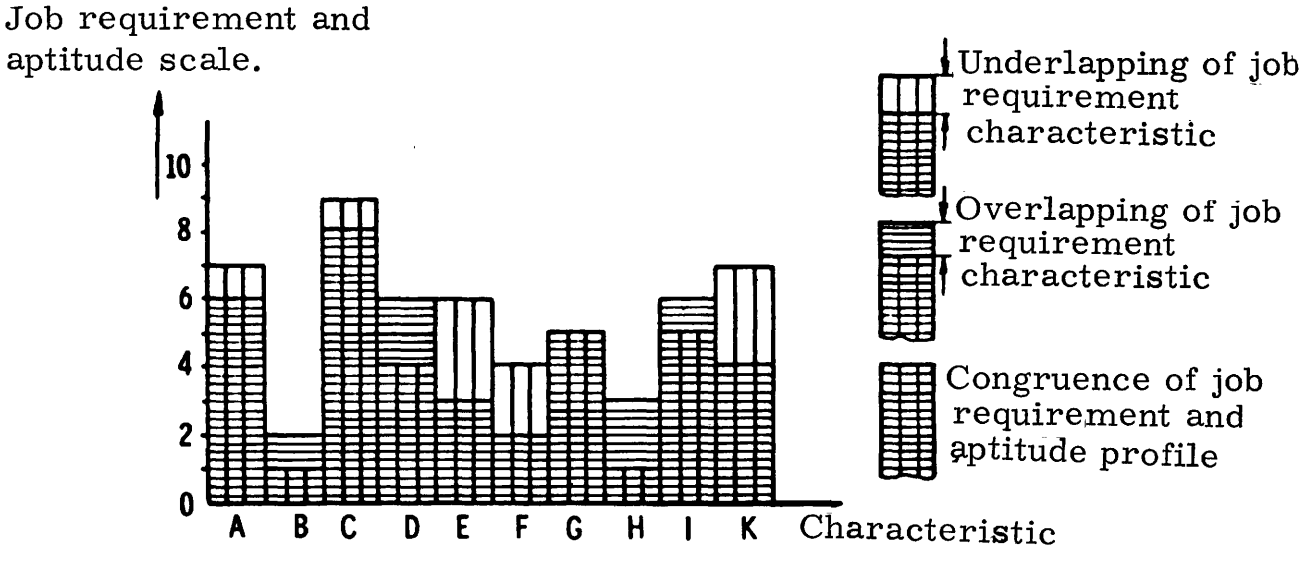

Fig. 3 : Comparison of job requirements and aptitude characteristics in profile form.

- The procedure is familiar to many industrial practitioners, on the work-place side through analytical job evaluation (e.g. by EULER/STEVENS 11) and on the personnel side because of the methods of assessing staff used in many enterprises.

- In determining the suitability of an applicant for a job several different study methods are often used and the procedure is frequently incomprehensible to the test subject and liable therefore to arouse a certain scepticism. In comparison the profile method has the advantage that its procedure and the way in which the results are evaluated are also comprehensible to persons who have only little experience of it.

On the other hand the disadvantages inherent in the profile method and in

its use should also be mentioned; they include the following :

- It may be objected to the breakdown of an overall structure of the workplace or individual into separate requirement criteria and corresponding aptitude criteria that interdependence between the individual characteristics will then not be taken into account. This objection is certainly justified but it carries little weight in view of the purpose of the profile comparison, especially because any overall characteristics which are not taken into account in the breakdown, can in fact be considered in the final assessment by the overall method, as described below. The critics of this method are also unable to suggest practical alternatives.

- In the profile method, if the studies are carried out by teams without good training and with little experience, there is a risk that despite the unified definition of requirement and aptitude criteria and the associated graduations, measurements may in fact be made by different standards at the workplace and for the individual so that the ascertained values may not be altogether comparable. However, in principle this risk of "unqualified use" exists with any method.

- Difficulties also arise in associating aptitude characteristics and their levels which can only be assessed in overall terms (on the personnel side) with the requirements determined in differentiated terms with the aid of suitable study methods (on the workplace side). For example, at the workplace the climatic load consisting of the components of air temperature, atmospheric humidity, air speed - summarized in the effective temperature - and thermal radiation can be determined exactly. It is, however, extremely difficult for the doctor to measure exactly, with the examination methods available to him, human ability to support heat. He can only make a rough estimate on the basis of circulatory data (e.g. the performance pulse index - PPI) and in certain chronic illnesses, the

degree of strain to which an individual may be exposed.

- On the other hand, it is also difficult to make exact observations in some cases on the workplace side as well. Professional experience for example can be determined as an aptitude from the previous career of a member of staff but it can often be described roughly as a requirement, e.g. because it is impossible to determine accurately how the necessary experience must be gained - from the same department of the enterprise, from a different department or from a different enterprise.

- JÄGER (32) draws attention to the difficulty that there are aptitudes which are bipolar in comparison with the corresponding requirements. For example, for many activities a specific degree of accuracy is required. If this level is exceeded accuracy related to this specific activity becomes a negative form of pedantry.

These limitations show that use of the profile method is not without problems. However, its advantages are certainly much greater in practice as is confirmed in the relevant literature (G. BERTELSMANN 2, page 67; R.B. CATTELL 5, page 775; Th. HETTINGE 26, pages 78-84; G.A. LIENERT 39, page 371; W. MÜLLER 44, page 184; H.T. SEEGER 60, page 50).

In ascertaining the level of requirements a distinction must be made between the two procedures outlined below.

Determination of the critical limits requires - as in the case of the procedure of lower norm values - the calculation and determination of a critical limit value for each feature; if this value is not reached on the aptitude side, use of the staff member or applicant at the workplace (JÄGER 32, page 636) will be ruled out.

When average values are used the profile presentation is based on the average requirements of the workplace concerned. For the subsequent

profile comparison to determine the degree of suitability of an applicant LIENERT (39, page 464) proposes as the comparison standard the profile similarity coefficient D which resembles in its mathematical derivation the standard deviation s.

To obtain data which can be used in personnel planning and to pre-select a group of suitable persons for specific workplaces or a group of suitable workplaces for specific persons or groups of persons by a rapid method, the determination of critical limits is preferable to the use of average values. Determination of a lower critical value is sufficient for a pre-selection and will still admit those job applicants or workplaces which might not come in for consideration when average values are used.

For the final decision on filling a post following the pre-selection, the overall method should be used to provide further information. The procedure adopted when the profile comparison is combined with the overall method falls into four stages (figure 4).

1) Pre-selection by a profile comparison

In relatively large enterprises it is often not possible to consider in detail extensive personnel records which are often only roughly classified and to work through a large number of job descriptions. When a job is filled - beginning from the requirement data of the workplace concerned - and in the search for a workplace - starting from the aptitude data of the person concerned - a pre-selection should be made using the profile method.

2) Intuitive interpretation of the profile comparison using the personnel records and job descriptions

After a number of individuals or workplaces reaching the minimum values - on the basis of the method of the critical limits - have been chosen, the availability of this group must first be examined. Persons who are not

available or workplaces which are fully occupied in the long term are ruled out. The personnel records or job descriptions for the available individuals or workplaces must then be located in order to interpret the profile comparisons intuitively with the aid of this documentation. Initially an ideal person for a particular workplace or an ideal workplace for a particular person must be determined before selecting a few particularly suitable persons or workplaces.

3) Discussion with the applicant

Perusal of the documents will probably not enable all questions relating to a future employment to be clarified. They can best be discussed in a

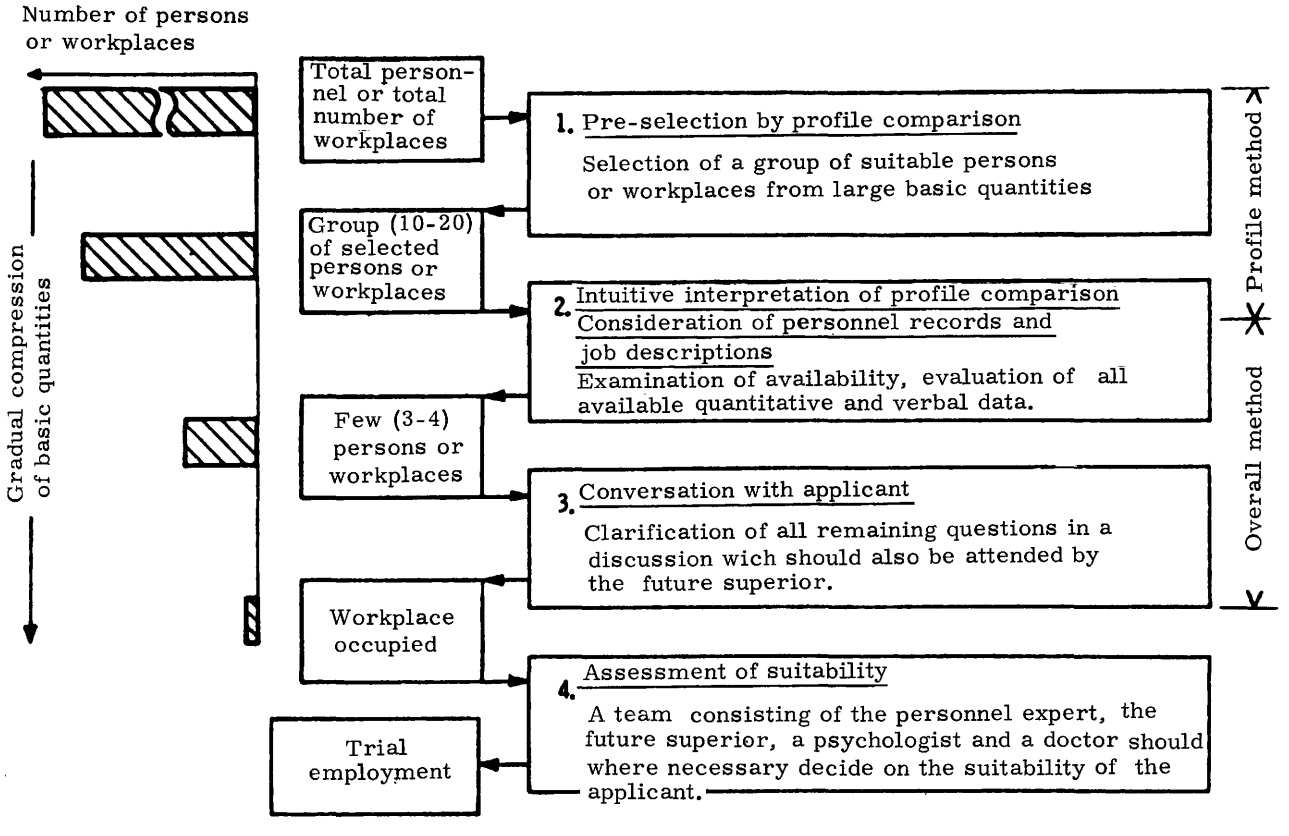

Fig. 4 : Summary of work phases in a combination of the profile and overall methods

conversation with the applicant who has generally not applied on his own initiative but been chosen by the profile comparison. The assessors can then gain a direct impression of the features, appearance and conduct of the applicant.

4) Assessment of suitability

Depending on the importance of the decision a psychologist and doctor, as well as the persons mentioned previously, should participate in the assessment, so that the decision on suitability can be taken by a team in which these specialists are also represented, each of them determining the suitability of the applicant from the standpoint of his own particular discipline. Finally the selected applicant is employed at the proposed workplace and a final test and assessment of his suitability made during a probationary period which often lasts for several months.

This procedure requires a great deal of time and cannot be used to fill all workplaces. However,as a function of the correction possibilities available where wrong decisions are taken, the time consumption can be reduced considerably. In exceptional cases aptitude may be determined solely on the basis of the profile comparison and consideration of the personnel records.

In our view the combination of the profile and overall methods is the best solution available at present for practical purposes. It has therefore been selected as the suitable method for processing the analyzed requirements and aptitudes. The following diagram (figure 5) summarizes the different methods once again, indicating the direction of the gradual improvement of the aptitude assessment when the methods are used expertly.

For practical application of the method proposed here suitable possibilities must of course be provided for taking into account the relevant provisions of the law on the constitution of enterprises (BetrVG) at all stages of the procedure. These provisions cover in particular personnel planning (92),

the advertising of jobs (93), personnel questionnaires and evaluation principles (94), selection directives for recruitment transfer and regrouping (95),

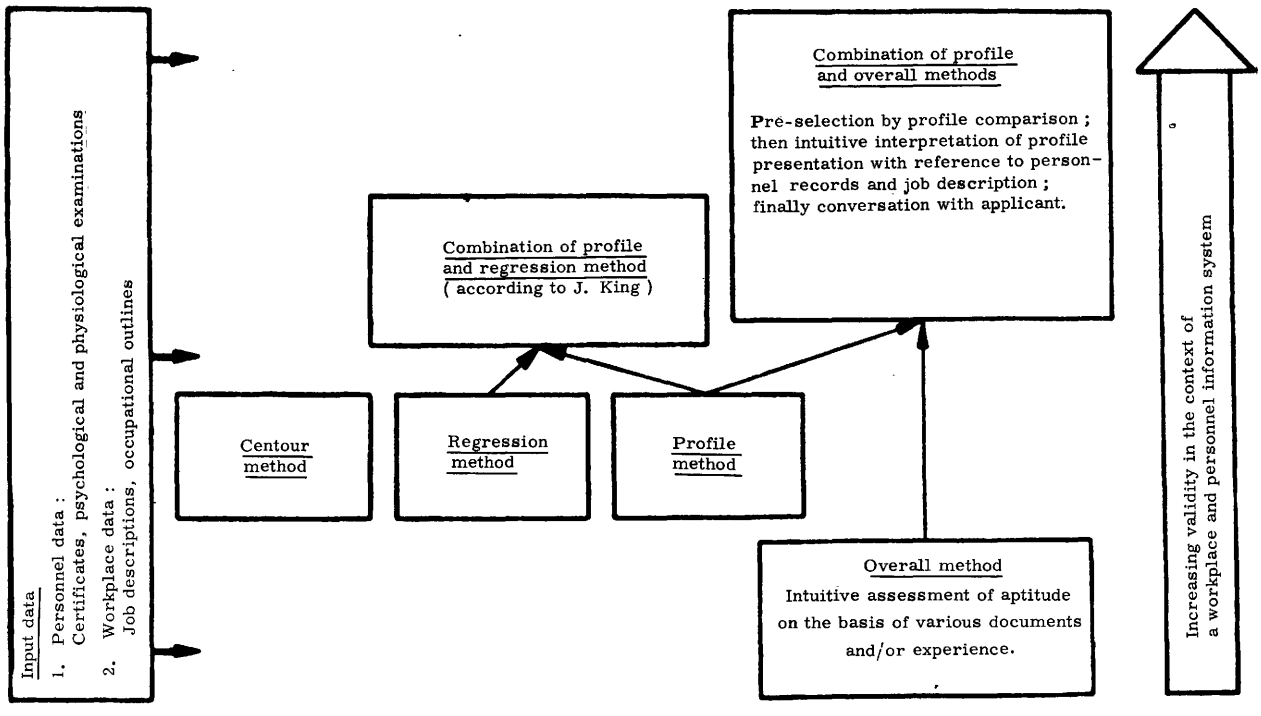

Fig. 5 : Summary of different methods for advance determination of the aptitude of an applicant for a particular workplace

individual personnel measures (99) as well as criteria for industrial safety, health protection, social facilities and accident prevention (87 - 88).

3. DEVELOPMENT OF THE CATALOGUE OF CHARACTERISTICS

3.1 Compilation of the maximal catalogue

In compiling the catalogue it was assumed that the acquired data would subsequently be used in a workplace and personnel information system (API). The aims of the tasks to be performed by an API for planning within an enterprise

partial tasks of personnel management, including

ergonomic workplace design and health protection,

form the framework for the characteristics to be included in such a catalogue with reference to the requirements which are or may be placed by the workplace on the worker. Bearing this assumption and the method of profile comparison in mind, the characteristics for this catalogue were developed and compiled according to the following criteria :

Completeness

All the requirements which are important to an activity must be covered and the distribution of the focal points of the information and of the requirements (JAEGER 32, page 624) must coincide. For the planning aspect, requirements expected to arise in future must also be taken into account.

Clarity

The definition of the characteristics must be clear in conceptual and operational terms; overlaps in the delimitation between the individual characteristics must be avoided (NUTZHORN 46, page 10).

Comprehensibility

Because of the desired use under practical conditions and the resulting requirement for easy application, the structure and the formulation of the instruments must be understandable without expert knowledge.

Feasibility

It must be possible to determine the characteristics with an expenditure which is reasonable in relation to the aims of the instruments.

The first step in compiling a catalogue of this kind was the development of a "maximal catalogue" which was then translated empirically into a form which was objectively adequate and also met the requirements of the planned practical application.

This catalogue was intended to list all the characteristics - arranged by appropriate groups - which needed studying on the requirement and aptitude sides. In compiling the characteristics and defining them, it was necessary to note from the outset that

- not all the characteristics would have the same weight for the requirements of different workplaces and that
- both requirements and aptitudes may occur at different levels (degrees of emphasis).

The characteristics were compiled in the catalogue with reference to the available documentation and experience as well as the relevant literature. It was impossible to adopt the method of job analysis developed for job evaluation - as used for the iron and steel industry in EULER; STEVENS' method (11). The requirement categories introduced in the methods of job evaluation are oriented, as a function of the intended utilization, towards the demands which may be raised by certain groups of activities. The system of concepts for evaluation has also been developed in line with this purpose. It is therefore not important for job evaluation whether a particular strain is tolerated easily or with difficulty by the individual concerned as it is only relevant as a partial parameter included in the job value. The attempt to use this system of concepts for the purpose of

this study - comparison of requirements and aptitudes - would therefore have been objectively impermissible. The maximal catalogue contained to begin with

144 different characteristics on the workplace side and

110 different characteristics on the personnel side

and was divided into the categories shown in figure 6.

1.	Workplace side	No of characteristics	2.	Personnel side	No of characteristics
1.1	General workplace data	68	2.1	General personnel data	10
1.2	General workplace data comparable with personnel data	10	2.2	General personnel data comparable with workplace data	10
1.3	Requisite knowledge	21	2.3	Knowledge	22
1.4	Medical, in particular physiological, requirements	26	2.4	Medical data, physiological aptitudes	34
1.5	Psychological requirements	8	2.5	Psychological characteristics	11
1.6	Workplace requirements which correspond to the staff assessment	11	2.6	Staff assessment	12
			2.7	Utilization of staff	11

Fig. 6 : Summary of main characteristic groups in the maximal catalogue

The reason for the different number of characteristics in the main characteristic groups on the workplace and personnel sides is that a summary was made initially of all the characteristics which it seemed possible to study as practically relevant requirement or aptitude data. This was done regardless of whether characteristics recorded on the workplace side could also be determined on the personnel side and vice versa.

The individual characteristics contained in these groups will not be examined here in further detail as a list and description of the characteristics at this point would lead to unnecessary duplication with the presentation of the catalogue used for the subsequent industrial studies. The large number of requirement and aptitude characteristics, the resulting variety of data to be recorded and the large number of workplaces and persons to be studied in order to examine the practicability of the instruments made it desirable to design the concept in such a way that the use of electronic data processing equipment was possible. As a result, a code list was added to the maximal catalogue which, through the breakdown into numerical symbols allowed the data which was to be recorded to be prepared in machine-legible form and processed easily. This method offers the possibility of providing effective data protection (see chapter 5.2.2.3).

As the code list which contains 60 codes in the first version was later integrated into the characteristics catalogue for the industrial studies,

		No. of codes
1.	General codes	3
2.	Codes for general workplace and personnel data	15
3.	Codes for main characteristic group - Knowledge	9
4.	Codes for medical characteristics	12
5.	Codes for psychological-physical characteristics	2
6.	Codes for psychologically determinable characteristics	8
7.	Codes for evaluation of staff	11

Fig. 7 : Summary of code list in maximal catalogue

at this point a summary is merely given of the initial group classification which corresponds largely to that of the characteristic catalogue used later.

3.2 Aims of the review to develop a catalogue for practical application

As mentioned earlier, the maximal catalogue was only suitable within certain limits, because of the great amount of work involved, as an instrument ready for trial in the context of studies under practical conditions. A review was necessary to develop the catalogue into an instrument suitable for practical use whose applicability was to be tested in the subsequent operational studies. The principal phase in this review was the conversion into an adequate form for profile comparison. It was necessary to clarify

- whether and if so with what limitations the individual requirement and aptitude characteristics could be determined in the enterprise;
- the probable validity of the individual characteristics in the context of an API;
- the modifications necessary to meet personnel policy requirements and provisions of the law on the constitution of enterprises (67) etc.;
- the changes required for the planned storage and processing with the aid of EDP systems;
- the possibilities to be included in the catalogue to analyze specific operational aspects, and finally
- whether the proposed priorities were sufficient to clarify the varying impact of the individual characteristics at different workplaces.

The working steps completed after clarifying these individual questions contain essentially the following aims with a view to modification of the maximal catalogue :

- Reduction of the number of characteristics by eliminating the repeated

investigation of the same aspects, e.g. in the case of the climatic load characteristic group which could in principle be covered both under the characteristics describing the work situation and under the physiological requirements of the workplace.

- Uniform structuring of the catalogue both in content and externally by ensuring maximum numerical uniformity of the requirements (on the workplace side) and aptitudes (on the personnel side).
- Direct correlation between characteristics and associated codes, including examples which are favourable for information purposes.
- Formulation of clear and readily understandable definitions and explanations of the characteristics and associated codes in particular to avoid overlapping of the individual characteristics.
- Review and provisional definition of possible survey techniques and aids with appropriate structuring by specialized disciplines relevant to the survey.
- Determination of the store space required to hold the recorded data after the review of the catalogue with the above aims.

3.3 Main characteristic groups, characteristic groups and individual characteristics

3.3.1 Preliminary note

Comparison of the acquired data in a profile comparison and storage and processing in EDP systems require as far as possible complete quantification or classification of the data to be recorded.

Characteristics as a whole can be divided into three types - in terms of the nature of the information - i.e. identifying characteristics (see chapter 3.3.2), descriptive characteristics (see chapter 3.3.3) and characteristics which define requirements or aptitudes (see chapter 3.3.4). Since distinct groups of characteristics became apparent within these three types - especially in the case of the characteristics which define requirements and aptitudes - the individual characteristics were classified by characteristic groups and

main characteristic groups (see fig. 8 in Chapter 3.3.3, page 46), to achieve a sufficiently differentiated but clear catalogue structure.

The individual characteristic of the catalogue described below and the overall structure were included with a few exceptions in this form in the catalogue revised again after the industrial studies. Exceptions were formed by the characteristics which were found after the industrial studies to be impossible or difficult to ascertain or to have low validity, and were therefore omitted from the catalogue. These characteristics are marked by an asterisk *) in the following description of the individual characteristics.

The attached characteristic catalogue (see Annex 8.1, pages 1-45) can be used for a comparison and complete survey - in particular with reference to the codes used. The individual characteristics can easily be detected with reference to the characteristic number. The formal structure of this catalogue was based on a unified series of headings which were still maintained when a proposed heading had no significance for a characteristic or group of characteristics.

3.3.2 Identifying workplace and personnel data

The identifying characteristics

- on the workplace side the workplace number (characteristic No. 1)
- on the personnel side the individual number (characteristic No. 30)

are used for clear designation of the workplace and individual and subsequently in the data banks of an EDP system as the store removal, sorting and search terms.

Workplace number (characteristic No. 1)

This generally consists of a classifying or area-defining information by means of which, e.g. the works, the works section or department in which the workplace is located are characterized. This is primarily applicable to stationary workplaces. In other cases, sub-functions of the enterprise are designated in the classifying part of the workplace number, e.g. in the case of an activity of internal transport or maintenance not confined to a specific plant. The workplace number also frequently contains the cost point with which the workplace is associated. It must therefore be assumed that workplace numbers - at least above a specific works size - consist of a multi-digit classifying and a multi-digit identifying part; different codes can be used for the classifying part in individual works. A number of this kind generally consisting of 6 to 8 digits can be used as a clear address for a workplace; 8 digits are provided in the data acquisition sheets.

Identification of the workplace may be completed for management reasons by additional data - such as the cost centre, classifying part with data on the enterprise area. To avoid excessive definitions and save storage space a stringent check should be made in such cases to determine whether the acquisition of additional data is absolutely necessary.

Individual number (characteristic 30)

The individual number is the permanent, clear designation of each staff member while he remains with the enterprise. Although in almost all industrial concerns the number of staff exceeds the number of workplaces because of shift work, multiple manning etc., the personal number gener-

ally has few digits as it consists of a strictly numerical expression.

The allocation of individual numbers within the enterprise may not be necessary if standard personal numbers issued by the State (69) as planned at present in the Benelux countries and in the Federal Republic, can be used. As these numbers generally contain the date of birth as the classifying part this item of information requested subsequently (see characteristic No. 60) on the personnel side might be omitted.

Workplace designation (characteristic 3)

In addition to the strictly identifying characteristics referred to above, the workplace designation already represents the transition to the descriptive characteristics. At present it exists almost exclusively in verbal form. Occupation or activity designations of varying degrees of precision or designations and formulations internal to the enterprise frequently dependent on the special production technology are used. Important changes in the workplace or activity due to the introduction of new process or organization techniques are often only introduced into the workplace designation after several years delay. This means that the workplace designations often provide no information on the purpose or content of the activity or may even give a completely misleading idea.

However, because of the need for verbal communication on the subject of workplaces it will continue to be essential in future to use verbal workplace designations even though they require a relatively large storage capacity with clear text storage and considerable word lengths.

To allow comparison and storage without excessive space, they should be coded with a numbered workplace summary (an example is shown in the

characteristic catalogue) or a classification index which is not peculiar to the individual enterprise. For the latter coding it will be essential to ensure precise and standardized formulations so that essential features of the activity can already be recognized from the workplace designation. One move in this direction is the occupation classification (76) which attempts to cover designations of occupational activities with a four-digit index.

Name (characteristic 31)

The surname, given name and title are essential for identification in daily conversation, so that it must be possible to effect a transfer from this identification to the other (personal number). Characteristic 31 is not, however, suitable as a criterion for classification in a data bank.

3.3.3 Descriptive workplace and personnel data

The descriptive characteristics are designed to give the most accurate information possible on activities or individuals.

Data at the workplace :

Not only the actual job content, i.e. the function to be performed by the worker, is to be ascertained at the workplace but also the characteristic data of the workplace or working area, the working means used and the work organizational conditions. In principle, this characteristic group also includes the environmental influences affecting the workplace. However, as these correspond directly with the physical and mental requirements, they are covered under the characteristics defining requirements and aptitudes.

Activity categories (characteristic 10)

To analyze the job content it is necessary to characterize the actions performed at the workplace by a catalogue of functions which is as uniform as possible for wage-earners and salaried staff and is not linked to a particular technology. Our experience shows that the determination of a maximum of five functions per workplace will be sufficient. It cannot be specified for the time being whether the degree of strenuousness involved in performing these functions should also be indicated as the necessary methods are not yet available.

It is therefore proposed that the activity to be performed at the workplace should be described in greater detail by the following functions (see LUXEM 40) :

1. Manual work
2. Assembly and dismantling
3. Conveying by physical effort
4. Control
5. Monitoring
6. Testing
7. Determining process data and work sequences
8. Leading other staff
9. Recording and classifying
10. Transmitting texts or figures
11. Drawing
12. Calculating

The precise definitions and typical examples can be taken from characteristic 10 in the catalogue of characteristics (see Annex 8.1). It should be immediately apparent that with the aid of an instrument of this kind, it is possible to recognize that the job content of what appear to be different workplaces is much the same because of unified functional structures. Over and above the determination of the relationship between

the content of activities, this instrument provides an important basis for the development of personnel planning methods, as it may be assumed that activities with similar content also show similarity in regard to the mental and physical requirement structure and the necessary training and can therefore be dealt with as a uniform group in a planning system.

Enterprise and work area (characteristic 11)

The determination of the position of the workplace in a specific enterprise and working area should

- on the one hand provide information on the present enterprise structure and
- on the other, offer the possibility of assigning workplaces to categories which meet identical conditions in regard to occupational experience.

Position in hierarchy (characteristics 12 and 13)

The information given here clarifies the existing organization structure.

Decision-making powers (characteristic 14), repetitive tasks (15*), group work (16*); degree of movement (17), training period (18)

The aim of these characteristics with those referred to earlier is to classify the verbal workplace description and thus arrive at statements which allow a comparison between individual workplaces.

Data on the personnel side :

The following items of descriptive data were included in the catalogue : Nationality (characteristic 32), address (33), and family status (34).

*) These characteristics are not included in the catalogue of characteristics. See sections 3.3.1 and 4.3.3

A large number of other descriptive items of personnel data (e.g. percentage absenteeism, wage payments, accident frequency) might form part of a comprehensive personnel and information system but, in agreement with the project Council, this data was not included in the catalogue to reduce the already substantial complexity of the study.

General comparative characteristics :

The two final descriptive characteristics are sex (characteristic 60) and age (characteristic 61). The purpose of attribution to these groups is to show that certain factors on the workplace side (e.g. legal provisions) may already lead to limitations on the use of personnel. On the personnel side indication of the date of birth will not be necessary if - as mentioned in 3.3.2 - the personnel number already contains the date of birth.

The characteristics of the catalogue which belong under the headings of "identifying" or "descriptive" characteristics were already explained in chapters 3.3.2 and 3.3.3. The dissimilarity between the number of characteristics on the workplace and personnel side and the fact that certain characteristics are valid either for the workplace side only or for the personnel side only, while the two last mentioned characteristics - sex and age - can already be used for comparisons between conditions on the workplace side and personnel data, made a rational grouping of these characteristics more difficult. For inclusion of these characteristics in the catalogue, the following grouping was finally considered expedient :

All these characteristics were assigned to the main characteristic group "General characteristics", sub-divided into three characteristic groups : "general workplace data" (A1), "general personnel data" (A2) and "general comparison characteristics" (A3).

Figure 8 gives a summary of this grouping of characteristics.

Characteristic group	Main characteristic group
A. General characteristics	A 1 General workplace data A 2 General personnel data A 3 General comparison characteristics
B. Knowledge characteristics	B 1 Schooling and technical training B 2 Occupational experience B 3 Further and advanced training
C. Physical characteristics	C 1 Muscular effort C 2 Posture C 3 Vision and hearing C 4 Functioning of limbs C 5 Other physical characteristics
D. Environmental influences	D 1 Climatic conditions, noise D 2 Dirt, water, chemicals, dust, gas, vapour D 3 Effects of mechanical vibrations
E. Psychological characteristics	E 1 Mental characteristics E 2 Work and community behaviour E 3 Sensory-motor characteristics E 4 Other psychological characteristics

Fig. 8 : Main characteristic groups and characteristic groups in the catalogue of characteristics

According to this summary all the subsequent comparative characteristics of the type "characteristics typifying requirements or aptitudes" are

arranged in main characteristic groups and characteristic groups with a close objective link between them. The individual characteristics making up the main characteristic groups, i.e. knowledge characteristics, physical characteristics, environmental influences and psychological characteristics, are explained in chapters 3.3.4.3 to 3.3.4.6.

3.3.4 Characteristics for requirements or aptitudes

3.3.4.1 General structure of characteristics

The basic breakdown of requirements and aptitudes into characteristics was outlined in the description of the profile method (chapter 2.3). The unified structure for presentation in the requirement or aptitude profile was developed for all characteristics (figure 9). Only the number of stages defining the individual characteristics differs. However, on the basis of the definition of stages, two types of characteristics must be distinguished :

- The first type includes those characteristics for which the stages are of a specifying nature, e.g. in the case of the alternating shift characteristic where a distinction is made between identical daytime working time and working time alternating between day and night. For presentation of this factor, each stage must be defined verbally.
- The second type includes all characteristics for which rising stages also characterize rising requirements or aptitudes. Where measurement methods are available according to the characteristic definition, a specific range of measurement results is attributed to each stage. Otherwise - especially in the case of psychological characteristics - each stage is once again described verbally.

The number of characteristic stages to be defined depends on :

- the need for direct comparability and
- the nature of the questions which the workplace and personnel information system is to answer later.

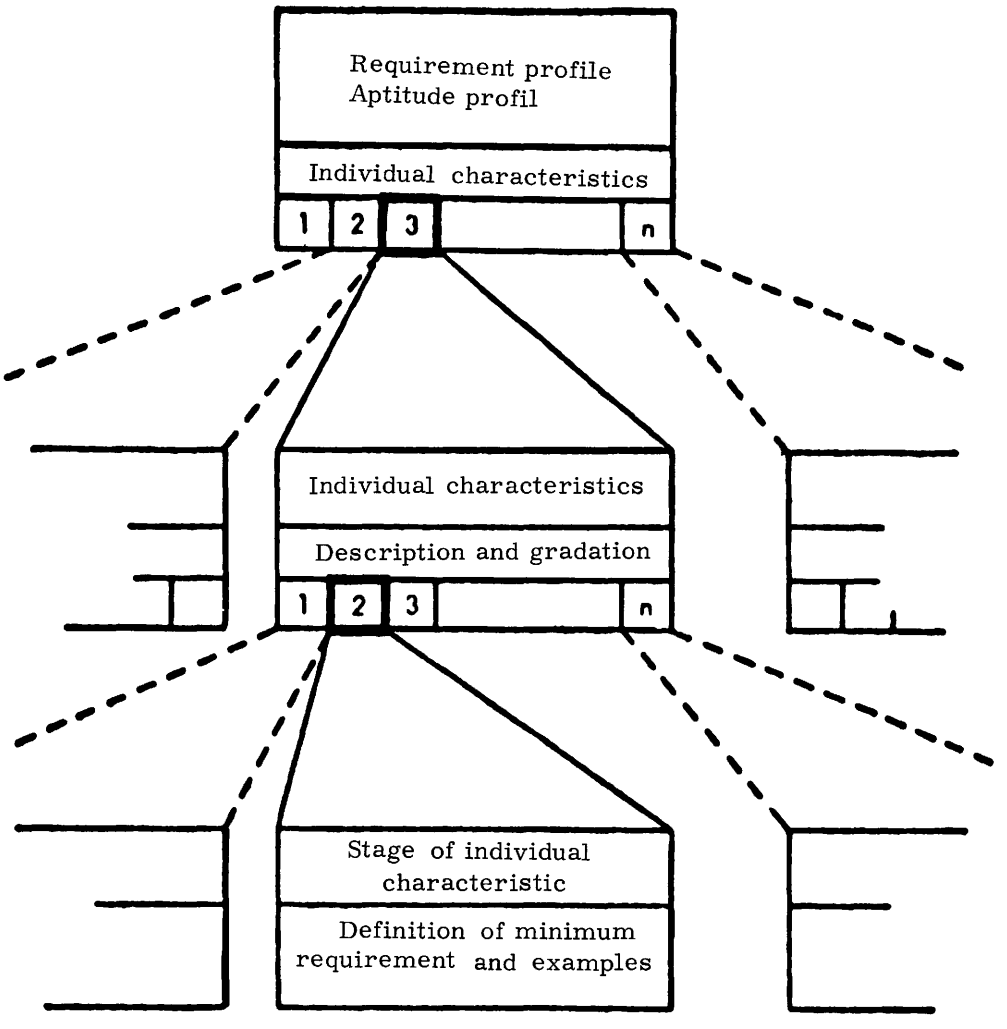

Fig. 9 : General structure of the requirement and aptitude profile

The lower the number of stages for each characteristic the easier it will be to compile the data and use the method in practice. At the same time the data alteration service which is essential to keep the system up to date will be held within reasonable bounds. Under these peripheral conditions, the profile comparison becomes an "exclusion system" consisting of a large number of minimum requirements with a minimum number of stages per characteristic. For industrial use, however, it is necessary to check with the works' doctor or psychologist to what extent supplementary characteristics and/or detailed characteristic stages may be appropriate for specific questions.

3.3.4.2 Definition of the importance of characteristics at the workplace by priority indexes

The differing importance of the individual characteristics for the workplace requirements and staff aptitudes referred to already in chapter 3.1 must be allowed for in further evaluation in the profile comparison. The direct comparison of requirement levels and aptitudes applied in many profile presentation methods - as proposed, e.g. by the Industrial Psychology Committee (66), the Expert Committee on Industrial Safety, Medicine and Psychology (74), JÄGER (32, page 633) and SIEBER, BECKER and ENGELHARD (61) - only allows for individual interpretation in the case of underlapping but does not enable an overall deviation index to be defined for the special characteristics of workplace requirements and personnel aptitudes. On the other hand, NUTZHORN (45, page 27) suggests that the workplace characteristics should not be juxtaposed on the same level but that the most important characteristics in each case should be defined because several characteristics concern "essential requirements which, if they are not met, mean that an individual is unsuitable for a workplace". TREBECK (63, page 236) also considers it expedient for "those pre-requisites which are absolutely necessary and can scarcely be compensated to be shown separately as centres of especial importance".

GOETZE and SCHLENGER (18, pages 1889, 1891) enquire "what requirements whose fulfilment is indispensable to the implementation of the aims of a workplace, must be placed on personnel" and distinguish according to this question between "certain pre-requisites which are essential for a position to be held" and "additional qualifications which guarantee complete exercise of a function from the outset". SCHÖNFELD (59, page 154) meets this requirement by developing a 'man specification', i.e. a summary of all requirement characteristics in the order of their importance. Similarly HILDEBRANDT (30, page VIII-5) defines "the

importance of the characteristics... by standards based on experience..., derived from the enterprise-specific aspects of the particular activity area".

According to the aims of the profile comparison described in chapter 2.3 a mean path was chosen between the weighting factors which can scarcely be determined accurately under practical industrial conditions on the one hand and simple methods without any differentiation on the other, by dividing the importance of the workplace requirements defined by the individual characteristics into four categories or priority stages :

- The highest priority stage with index 3 is attributed to all characteristics whose fulfilment in the indicated requirement level at the workplace is absolutely essential, i.e. the activity can be performed at the relevant workplace only if the applicant meets the required level of the characteristic. As an example of a specific requirement given priority index 3, possession of a class 2 driving licence would be essential for the post of truck driver (see characteristic 170).

- The priority stage with index 2 includes all characteristics which must be met for the orderly performance of tasks at the workplace in the requirement stage indicated. Only in exceptional cases, may the fulfilment of the characteristic in the required stage (where compensation is expected by another characteristic) be unnecessary. An example for this is the requirement for a completed apprenticeship at the "universal lathe" workplace. Only under specific conditions may this requirement be compensated by appropriate professional experience.

- Priority index 1 designates all characteristics with which compliance in the given level is considered desirable at the workplace. It would for instance be desirable for a fitter who travels abroad to have some - even if rudimentary - knowledge of English.

- Priority index 0 is attributed to all characteristics which are generally investigated in the context of the profile comparison but do not occur as requirements at the workplace concerned.

In the catalogue of characteristics (see Annex 8.1, page 2) all characteristics are preceded by a priority code.

This designation of the importance of requirement characteristics for the individual workplace is backed by a further evaluation of all characteristics which - as mentioned in chapter 3.3.4.1 "General structure of the characteristics" - have stages for increasing requirement or aptitude levels. This proved necessary after it was found in the classification of industrial workplaces that there were cases in which individuals might still just meet all the minimum requirements carrying high priority indexes and nevertheless only seem to have limited suitability. In order to show that the next higher aptitude stage should be reached to ensure complete suitability in the case of a number of characteristics, the next higher requirement stage was selected instead of the minimum requirement stage for these characteristics and associated with the next lower priority index.

In a profile comparison for a characteristic of this kind, the requirement stages defined as minimum requirements with maximum priority are first compared with the aptitude levels. A check is then made to determine whether the next higher requirement stage whose importance was reduced by one priority stage for the workplace is still met in the case of the characteristic concerned. This additional comparison can follow the

profile presentation and evaluation without too much difficulty when a computer is used as described later.

3.3.4.3 Knowledge characteristics

This main characteristic group is divided into three characteristic groups :

- schooling and technical training
- occupational experience
- further and advanced training.[1)]

Special importance attaches to the first two characteristic groups because a number of physical and psychological requirement or aptitude levels may be derived from them - particularly on the workplace side. Technological development - changes in job content, working instruments etc. - is increasingly loosening this narrow relationship as there is no corresponding change in the designation of workplaces and professional experience. In the absence of alternatives, indication of training and occupational experience will continue to be inevitable for the foreseeable future. In addition, the indication of schooling, technical training and occupational experience - quite apart from the requirements of the workplace - frequently plays an important part for enterprise-specific planning in the area of personnel management.

The individual characteristics of these groups are explained below in accordance with the above structure; the catalogue of characteristics appended to this report may be consulted for further information. The schooling and technical training characteristic group includes :

Schooling (characteristic 100)

The required types of school and leaving certificate have been coded

1) The occupational education law of 14.8.1969, § 1, uses the designation "further occupational training" but we still prefer to use the synonym "further and advanced training" which is usual in enterprises.

in a joint set of stages. In defining a code to classify vocational training schools it was particularly important to ensure that both old and new school systems could be clearly covered in the classification, to ensure the requisite comparability between requirements and aptitudes.

Technical training (characteristics 105 and 106)

A distinction is made between the type and level of the required or actual training. The type is coded with the aid of the occupational classification published by the Federal Statistics Office in Wiesbaden (76) (characteristic 105).

A combined code was developed to determine the level of training for activities which must be learnt by practice; it contains a time indication and for training involving a final examination an indication of the type of examination (characteristic 106).

The second characteristic group, i.e. occupational experience, is used to characterize the activities required at the workplace or previously performed by the staff member concerned. A maximum of two activities can be covered at the workplace and up to five for the staff member.

The occupational experience required or desirable at a workplace is limited either to specific occupations and/or specific activities in the enterprise. In addition, the long-term use of skilled workers is generally not planned beyond a total of three successive activities on the career principle. As a result - as the industrial studies confirmed - storage facilities for two items of occupational experience will be sufficient.

The position is different on the personnel side where several types of occupational experience may be acquired by frequent changes of job beyond limited sectors or occupational categories. However, because of technological change, occupational experience gained too long ago

is not generally usable, so that in this instance the storage of not more than five activities was considered sufficient.

Because of the wide variety of possible questions as to
- origin expressed by workplace number, enterprise and work sector or branch
- nature
- level and
- duration of occupational experience

it was necessary to provide a total of six different characteristics, not more than four of which were required for clear classification. The individual characteristics are explained in more detail below :

Characteristics which describe origin

- workplace number (see characteristic 111)
- enterprise and work sector (see characteristic 112)
- relevance of experience to branch (see characteristic 113)

indicate where desired occupational experience should have been acquired. There is an increasing process of generalization from the "workplace number" to the "relevance of experience to the branch". As the profile comparison is an exclusion method and sets out from minimum requirements, the broadest possible generalization is desirable for this data on the workplace side. As a result of this dependence of the characteristics, only one of them must be indicated and accordingly only one priority index. On the other hand all three characteristics should always be shown on the personnel side.

The workplace number or enterprise and work area characteristics have already been discussed (see characteristic 1 or 11) and the "relevance of experience to the branch" characteristic (number 113) only looks into the sector of the economy in which experience was or should be gained.

The nature of the occupational experience (characteristic 114) is indicated with the code for classification of occupations already used under the heading of technical training.

The level (characteristic 115) of qualification requirements is covered by the same scale as that used for technical training. The qualification requirements, with an indication of the occupation category, relate here to the level of experience in this occupation category and if there is no indication the requirement is generally valid, i.e. the occupation in which it was acquired is not relevant.

The indication of the duration (characteristic 116) of certain types of occupational experience may be used as a requirement characteristic - in particular for training gained by experience - because in general certain minimum times can be indicated for the acquisition of special knowledge to gain the requisite qualifications for promotion from one workplace to another etc.

The workplace designation (117*)) is indicated by the same code as characteristic 3 to supplement the workplace number (characteristic 111) and the occupational class.

By the additional "and/or" provision in characteristic 118, it is possible to indicate on the workplace side whether

- occupational experience in a further activity is desired ("and") or whether
- the required occupational experience can be replaced by a different kind ("or").

In addition to experience of previous activities the third characteristic group "Further and advanced training" may be of decisive importance in

*) This characteristic is not included in the catalogue of characteristics. See chapters 3.3.1 and 4.3.3

filling a workplace. This broad range of additional requirements or qualifications is sub-divided as follows :

- Generally valid qualifications :
  As there is not yet a systematic classification in the area of further and advanced training covering all conceivable additionally specified or available qualifications, this heading covers only, e.g. driving licenses (characteristic 170) and Refa certificates (characteristic 171*)).

- Enterprise-specific and other qualifications :
  The large number of necessary certificates of aptitude is covered with the aid of enterprise-specific codes (characteristic 172). In addition it should be possible to cover in clear text (characteristic 173*)) the further training measures which are so uncommon or of such limited importance that they are not shown in characteristic 172.

- Knowledge of languages :
  The necessary and existing knowledge of German in the case of foreign workers (characteristic 180*)) and knowledge of up to three other languages (characteristics 181-183) are indicated here.

Chapter 4.1 contains information on the methods of determination on the workplace and personnel sides.

3.3.4.4 Physical characteristics

In the main characteristic group "Physical characteristics" dealt with next, investigation is often confined in the case of skilled workers in the iron and steel industry to the characteristics "Muscular load" and "Work under raised temperatures" used to determine wage levels. Only for special workplaces (crane driver, lorry driver, locomotive driver, shunter etc.) is the examination generally extended, e.g. to include requirements for vision and hearing. For firemen and at workplaces where sandblasting is done or soda vapours encountered in paint shops etc. the ability

*) These characteristics are not included in the catalogue of characteristics. See chapters 3.3.1 and 4.3.3

of the applicant to work with a respiratory mask is considered and in the case of furnace masons, roof repairers etc. ability to work at heights is also taken into account.

This differentiated application of a different catalogue of characteristics is primarily due to the fact that in the case of psychological characteristics the classification of workplaces involves many difficulties. These consist on the one hand in the fact that there are not yet any suitable means of measuring certain requirements - satisfactory methods are not for instance available to determine the precise vision and hearing requirements at a workplace. On the other hand difficulties are often due to the fact that despite the existing methods in some cases it is scarcely possible to define the minimum requirements for certain workplaces. For example, in the case of group work the stage value of a characteristic below which success cannot be expected at the workplace depends on the average value reached by the group and the willingness to help a colleague who lags behind in one characteristic.

These procedural problems are often accompanied by personnel difficulties. In most enterprises the industrial medical department would be overloaded if it were to attempt to examine in detail a large number of different workplaces in terms of a large number of characteristics. A unified, scientifically placed set of instruments should therefore be developed to study medically relevant job requirements; these instruments would have to be recognized by all industrial doctors while being sufficiently simple to use for a non-physicial to be able to categorize a series of physical characteristics of the workplaces.

On the personnel side substitution of this kind will not be possible as only a doctor can correctly classify a staff member with reference to physical characteristics and impermissible ambient influences. According to this principal task which is that of health care, the industrial doctor will not begin by considering the required aptitude characteristics; he will first obtain an overall medical impression of the subject by checking the circulation, examining the lungs, analyzing the urine, looking into the past history of illness and so on.

The aptitude profile is therefore generally drawn up at the end and here too the classification is effected largely on the basis of health care criteria, i.e. susceptibility to specific illnesses, fatigue symptoms etc. have a considerable effect on aptitudes.

In the context of our research project we therefore attempted to compile a list which was as complete as possible of physical requirement and aptitude characteristics

- allowing easy recording on the workplace side
- keeping the demands on the industrial medical service within limits on the personnel side, and
- meeting the requirements of the profile comparison.

The main characteristic group "Physical characteristics" contains the following characteristics chosen after many discussions with industrial doctors :

1) Muscular effort (characteristic 200)

The intensity and duration of the muscular load is indicated by muscular effort. The stages of muscular effort are not delimited by descriptions and examples as in the case of the corresponding requirement "work strenuousness" of EULER and STEVENS (11, pages 52, 53), the analytical evaluation of job activities (75, page 32) or by NUTZHORN (45, page 89), but are determined by the two reference values working calories (indication of energy turnover) and/or working pulse rate (circulatory load). Both values can be determined at the workplace with appropriate measuring instruments (HETTINGER 26, pages 59-70).

In determining the working calory index, the expired air volume is generally determined with a portable gas measuring instrument and an air analysis made so that oxygen consumption can be calculated during a given period of time and from it the energy turnover.

The pulse frequency is measured with the aid of electrodes or by the photocell principle at the ear and transmitted to an evaluation instrument. This method is often described as telemetric measurement in industrial measurement with reference to the method of transmitting the results. As the equipment only has the size of a cigarette packet, this method can be used at almost all workplaces. In this connection, PREUSCHEN (50) reports on a pulse measuring instrument combined with an observation plotting unit for working studies so that each individual pulse frequency peak value can immediately be commented on.

Conversion of the working pulse frequency - obtained as the difference between the pulse frequency measured during work and the pulse frequency at rest - into the corresponding calory consumption is possible by approximation. As shown from studies by ROHMERT and HETTINGER (27) the permissible energy turnover limit for man is approximately 2,000 working calories per eight hour shift or 4.17 working calories per minute, and the limit of the acceptable circulatory load is 40 working pulses per minute. HETTINGER, PAQUIN and SUCKER (29, page 19) conclude from this that in dynamic work "...one working calory corresponds to about ten working pulses. In the event of any departure from this ratio - the working pulse frequency is then higher than would be expected on the basis of the calory consumption - the work contains climatic factors or static working elements". Starting from the measured pulse frequency, these elements may be converted into pseudo-calory consumption and used as a load value in assessing the workplace.

As pulse frequency measurement is relatively easy to carry out but involves complex preparatory work and evaluation, the use of a method of this type will often not be possible in the context of a comprehensive analysis of the workplace requirements. Instead the working calory consumption can be determined for uniform activities or activities recurring at regular intervals with only slight deviations by the "calory conversion tables for physical work" compiled by SPITZER and HETTINGER (62). If a number of activities with widely varying content and extent are carried out at a workplace, an estimate must be made with the occupational activity calory values which appear at the end of the tables. Especially in the case of this estimated method, it is desirable, in order to determine the error of the estimate and train job analysts, to carry out additional telemetric pulse frequency measurements at a number of typical workplaces (see chapter 4.1).

The relevant literature should be consulted for details of examination possibilities on the personnel side to determine possible muscular stress.

Characteristics

2) Brief peak load (characteristic 201) and

3) Bodily posture (characteristic 210)

involve questions regarding short loading by lifting or carrying heavy weights and the problem of work which has to be performed in specific body postures. For the classification, reference should be made to the annexed catalogue.

4) Visual acuity (characteristic 220)

The visual acuity characteristic belongs with the group of characteristics referred to in chapter 23 which can be easily measured on the personnel side. Suitable measurement methods are not yet available for classifying the necessary degree of visual acuity at the workplace. The methods described in literature (BURKHARDT and SCHOLZ 4; SCHMIDTKE and SCHOBER 58) are so detailed that they can only be used in exceptional cases. It would probably be much simpler to train a job analyst on the basis of visual charts and subsequent assessment of the visual acuity required at the workplace.

NUTZHORN (45, page 89) also adopts this practical solution based on an aptitude measuring process to assess a job requirement; he has compiled a nine-stage code which is subdivided into ten percent steps according to the vision determined by the doctor or optician. A distinction is made between near sight and long sight. This code was reduced to three stages which can be easily differentiated at the workplace, additional allowance being made for differences in the visual acuity of the two eyes. Since near and long sight defects can be corrected by spectacles, a second code is not necessary. Instead eye specialists recommended maximum eye correction values for the individual stages as proposed in a similar manner by HETTINGER, KNIEB and NIEMANN (28, page 9).

The comparison necessary in such methods - training job analysts on the basis of visual charts etc. - with precise measurement data to achieve the most accurate classification possible and in particular a classification which has a relatively unified basis for all workplaces, should be repeated from time to time.

5) Spatial vision (characteristic 221)

The necessary direct comparability between requirements and aptitudes for the profile comparison means that it is only necessary to ask whether normal eyesight is needed. Examination of anomalies, limitation of the field of vision, faults in binocular vision or movement defects is not required, as these defects cannot be ascertained at the workplace in the absence of appropriate measuring methods.

6) Colour vision (characteristic 222)

For the same reason, no investigation of blue-yellow blindness, red-green blindness or red-green weakness is provided for under this characteristic and only complete colour vision required on the workplace side or alternatively not required; it will be ascertained where necessary by the doctor.

7) Hearing power (characteristic 226)

The hearing power is classified in the same way as visual acuity. A high level of deafness which also makes verbal communication with other persons practically impossible is not covered, as the individuals concerned must in any case be employed at special workplaces where few working instructions have to be given and which can be reached without movement risks (crossing roadways or rail-tracks without clear visibility etc.).

A distinction is therefore only made between good hearing and slight deafness. As a boundary value, PLATH (48, page 68) indicated that

good hearing for speech and acoustic signals is present when the mean hearing loss at the frequencies of 500 Hz, 1,000 Hz and 2,000 Hz does not exceed a value of 25 Db. At the same time the hearing loss at 3,000 Hz should be lower than 40 dB. To determine these boundary values at the workplace it is first necessary to investigate the hearing power of the job analyst. If the works' doctor finds that the analyst's hearing power lies above the boundary value, he can set the boundary value precisely on the basis of various background noises and then allow the job analyst to determine it so that a subjective but relatively accurate classification is subsequently ensured at the workplace.

8) Function of members (characteristic 230)

As impaired performance of the limbs may be noted in a number of staff but has no influence on working results at a great many workplaces, the permissible limitations of functional efficiency are included in the profile comparison at the workplace. The limb schedule (13) used to fix pension and accident compensation rates is taken as a reference value for classifying the necessary functional efficiency. This schedule prepared for the insurance companies presents all possible losses or stiffness of the limbs; these phenomena are explained briefly and percentage indications of the reduction in performance given. This information forms the basis for two identical three-stage codes for separate classification of the upper and lower limbs.

9) Alternating shift (characteristic 240)

This characteristic has been included under the main group of physical characteristics because workers may suffer considerable physical strain due to the changing meal and sleeping times in alternating shifts and difficulty in sleeping in the daytime. KIRN (36) is of the view that for these reasons 20 % of all workers are not suitable for alternating shift work. In addition this characteristic must be compared with characteristics 60 and 61, sex and age, in order to guarantee the observance of legal provisions regarding work by women, protected age groups etc.

10) Fitness for wearing mask (characteristic 241)

At some workplaces, e.g. when a great deal of dust is developed, half masks must sometimes be worn over the mouth. Other workplaces at which harmful vapours etc. may occur, e.g. soda vapours, waste gases from converters during necessary maintenance work - may make it necessary to wear heavy respiratory devices. On the personnel side, the industrial doctor must therefore decide whether a staff member can wear one or other type of mask.

The two following characteristics

11) Freedom from giddiness (characteristic 242) and

12) Sudden occurrence of shock, pain or loss of consciousness (characteristic 243)

are not classified in stages as there is simply a yes/no answer in respect of the requirements on the workplace side or existing limitations on the personnel side.

3.3.4.5 Environmental influences

In the main group "Physical characteristics" the requirements of the workplace must be met by active ability of the staff member to perform the work involved. On the other hand environmental influences require an ability to withstand passively - without detectable damage - negative environmental influences. The reason for showing these factors as a separate group is that environmental influences not only affect the physical constitution of personnel but also have substantial vegetative and psychological effects. There is therefore a special problem in determining boundary values.

The differentiation of the main characteristic groups into characteristic groups and individual characteristics can be made on the basis of cause or effect. While the causes exist on the workplace side, the effects occur on the personnel side. As effects generally consist in limitations of abilities which existed previously, these limitations must be identified by the industrial doctor who will indicate an inability of the subject to support certain environmental influences. In addition, harmonization of requirements and aptitudes can only be achieved in this case by changing the causes, i.e. by an appropriate ergonomic workplace design.

The special features of the individual characteristics not mentioned in the catalogue of characteristics (annex 8.1, characteristics 300-321) are explained below.

Climate (characteristic 300)

The climatic load encountered in industry, and in particular in the iron and steel industry, has been partly removed by mechanization and automation. However, there remains a not inconsiderable number of workplaces at which special requirements are created by high temperatures and/or radiation heat. As already mentioned in chapter 2.3, the components of air temperature, atmospheric humidity, air speed and heat radiation are decisive for a comprehensive measurement of the climatic load. To determine a climatic load corresponding to the subjective impression of the worker, the effective temperature must be determined. YAGLOU's method (65) was chosen from the wide range of possible physical measuring calculation methods for technical reasons; in this method after measuring the dry temperature, humid temperature and air speed, the effective temperature can be read off from a nomogramme. If heated objects are situated in the vicinity of the workplace, radiation is also measured and evaluated separately or integrated with the effective temperature in a total climatic load value - known as the corrected

effective temperature. Details of the instruments used, on the performance and evaluation of the measurements and on the human ability to withstand climatic loading will be found in the relevant literature (GRANDJEAN (20, p. 251), HETTINGER (26, p. 45-53), MÜLLER (43, p. 22-31), RICHTER (51, p. 291), WENZEL (64, p. 305-307) etc.).

Because of the many uncertainty factors which limit assessments of the human ability to withstand climatic load - e.g. workload, perspiration, food consumption, age, clothing - the requirement characteristic is only classified in three stages. These can be taken from a table compiled by HETTINGER for the profile comparison described here; this table shows the effective temperature and heat radiation range as a function of work strenuousness (characteristic 200).

Noise (characteristic 301)

While precise measurements are possible on the workplace side through the existing noise level - measured by the internationally agreed Db (A) scale (see MARGGRAF 41, page 1530) - the limit above which physical and psychological disturbances occur in the individual cannot be determined accurately in general or individual cases. VDI Directive 2058 (78, page 5) indicates, however, that a noise level in excess of 90 Db (A) causes irreversible hearing damage in most individuals. JANSEN (35, page 377) holds the view that in the psychological area too the critical noise intensity level is about 90 Db (A). GRANDJEAN (20, pages 204, 205) observes that speech communication can be considered satisfactory when the sound pressure of the speech is 10 Db (A) higher than the average noise intensity. Consequently, a noise intensity of 60-70 Db (A) already considerably impairs understanding and is felt to be unpleasant.

Stress on skin (characteristic 310)

Because of the many possible limitations on the personnel side due to allergies and similar illnesses, this heading is simply used to determine whether the handling of dirty objects, oil, grease, chemicals etc. is liable to place strain on the skin.

Stress through dust, gas and vapour in the air (characteristic 311)

Here too there are a large number of possible limitations; in addition, however, a distinction is made between unpleasant and harmful dusts etc. (see FLÜGGE 15).

Effects of mechanical vibrations on the whole body (chracteristic 320) and on the hand-arm system (characteristic 321)

Extensive vibration measurements are not carried out to classify these two characteristics; we simply ascertain whether vibrations occur and for how long they act. When an individual is to be allocated to a post, his aptitude must be examined by the works' doctor and further analysis of the vibrations occurring at the workplace may be necessary.

Vibrations falling within the natural frequency range of parts of the body are particularly unpleasant : for the whole body approx. 4-6 Hz, for the head approx. 15-20 Hz and for hand, elbow and shoulder joints approx. 20-40 Hz. Guide values for these vibrations are indicated in VDI Directive (77) and ISO Draft (73).

DUPUIS and HARTUNG (9) show that the mechanical vibrations to which an employee is exposed at his workplace are generally not sinusoidal variations as previously supposed but often stochastic, i.e. random vibrations, to which man responds 10 to 45 % more sensitively, depending on frequency, than to sinusoidal vibrations.

3.3.4.6 Psychological characteristics

Suitability for an occupation or workplace does not depend solely on existing knowledge and physical aptitude but also on psychological characteristics. Technical and organizational changes - e.g. increasing mechanization and automation - mean that individual psychological requirements are reduced while there is also a growth in other requirements (e.g. heightened requirements for technical understanding in the case of maintenance workers because of mechanization; increasing monotony because of the more thorough division of labour). The inclusion of individual characteristics in this catalogue does not, however, mean that disagreeable psychological demands are accepted (e.g. monotony,ability to work individually) but that - starting from the present state of the workplaces - these characteristics must be included in the catalogue to characterize the requirements. Increasing importance therefore attaches to the analysis of this main group of characteristics in order to indicate in good time desirable and undesirable developments of individual types of requirements and take remedial action where necessary.

The procedure for determining psychological requirements and aptitude characteristics can only be outlined briefly here as they only affect the project peripherally; in any case there is a huge volume of literature on these questions and the problems to be taken into account. Reference should be made to modern psychological literature for information on the methodological difficulties facing psychologists in the task of allocating candidates to optimum workplaces according to their aptitudes and characteristics.

For determination and listing of the relevant psychological characteristics, the first need was for them to be delimited and defined in identical terms on the requirement and aptitude sides. The specific difficulty in this case was that these performance characteristics can

only be determined descriptively. It could not be assumed that there were existing human aptitudes which could be appropriately used - to varying degrees - by the demands of specific workplaces.

The characteristics were ascertained in such a way as to meet the following criteria determined by JÄGER (32) on the requirement side :

" 1) A conceptually and operationally clear characteristic definition (in terms of information about the applicants)
2) A sufficiently differentiated and comparable characterization of the degrees of emphasis
3) Occupation-specific significance (correlation with occupational success)
4) Further information on relation between occupational success and existence of certain characteristics, in particular the relevant regression forms, the optimal presence level and the critical limits".

It was clear from the outset, however, that it would be impossible to meet the stringent criteria completely while remaining within feasible practical limits. With the aid of characteristic definitions, corresponding to the first point and of step definitions for each characteristic relating to the second point, the two most urgent requirements would be met. As regards the third and fourth points, efforts were aimed more at their indirect observance.

Information on requirements and aptitudes must be uniformly structured, i.e. according to HERWIG and DIRKS (25), it must follow the same practical structural typology. A further important pre-requisite for a comparison of characteristics is the operationally identical appraisal of characteristics on the requirement and aptitude sides (CATTEL 5). As fundamental research has not yet been able to "achieve general recognition for any of the numerous theories of the structure and dynamic

of personality and conduct" (see JÄGER 32, page 619), this requirement will presumably not be met for the time being.

Not only because of this limitation but also because of other methodological and practical difficulties "stop gap methods" will no doubt continue to be used for a long time in the enterprises. In the view of industrial psychologists, this procedure nevertheless justifies the usual diagnostic methods which have a demonstrably high validity for certain occupational activities (GREWE; MESECK 21).

In obtaining information on requirements and aptitudes, it is expedient to begin from workplace data, i.e. from the requirements in order to determine important characteristics for the occupation, their optimum degrees of presence and critical limits. Further special aspects to be taken into account were that

- some of the characteristics were inter-correlated,
- a compensation, i.e. balancing out underlapping of one characteristic by overlapping of another, is possible to a much wider extent than with the main characteristic groups referred to above,
- for most psychological characteristics, especially on the requirement side, there is as yet no measuring method for precise determination of the characteristic levels.

Each characteristic and the associated characteristic stages should therefore be defined with particular care and the stages explained by meaningful examples in order to avoid wrong interpretations and assessments.

The following points had to be borne in mind on the personnel side :

The aptitudes to be determined of staff or applicants and compared with the

requirements in order to determine whether and to what extent the workplace requirements of a specific characteristic are met can in principle be determined under the same descriptive characteristic and step definitions as on the requirement side. It is for the examining psychologist to decide how the performance-related characteristic is to be interpreted in psychological terms. Afterwards, he must transpose the examination findings obtained with the aid of the methods selected and used by him and their diagnostically processes results into the form of the descriptive characteristic definitions. The aptitudes expressed in this way must not, however, be misunderstood as being inherent in this form in the individual; they are indicated in the following aptitude characteristics with that limitation.

Some of these aptitude characteristics can be graduated more precisely than is possible on the requirement side because the calibration of the tests used by mathematical and statistical methods enables the results to be classified in aptitude stages given by this calibration. Meanwhile it must be noted that the classification gives a group diagnosis rather than an individual diagnosis. The special qualifications of a psychologist consist partly in the fact that, starting from a group diagnostic result, he is able to determine by individual diagnosis the aptitude available to the person under this particular characteristic in terms of its existence and degree of presence. This means, as is often forgotten in general views on the applicability of tests, that the individual degree of presence of an aptitude cannot merely be detected from test results obtained but that these results simply provide the material for further processing. This also applies to the determination of aptitudes and aptitude stages designed to allow the initial selection of groups of individuals. The characteristic

and grade definitions of the psychological characteristics as well as the explanation attached to the grade definitions in the form of examples - as for the other main characteristic groups - will be found in the attached catalogue of characteristics (annex 8.1, characteristics 400-462).

The psychological characteristics as a whole are sub-divided into the following groups :

- mental characteristics,
- working and social behaviour characteristics,
- sensory-motor characteristics and
- other psychological characteristics.

The "mental characteristics" group (E 1) consists of the following items :

	Characteristic No.
Perceptive faculty	400
Practical skills	401
Technical understanding	410
Organizing and arranging ability	411 *)
Powers and observation	412
Mathematical skill	413
Oral/written powers of expression	414
Motion and distance evaluation	416 *)
Spatial perception	417

The second characteristic group (E 2) designated "Working and social behaviour" consists of characteristics representing relatively stable behavioural features. These characteristics relate either the

*) These characteristics do not appear in the catalogue of characteristics. See chapters 3.3.1 and 4.3.3

attitudes to the individual's own work and given working conditions or to social characteristics relevant to the workplace and enterprise; they are therefore significant on the requirement and aptitude sides. To grade most of these characteristics on the requirement and aptitude sides estimates usually have to be made which can be usefully supported by the discussion of examples in order to arrive at meaningful guidelines. This group includes the following characteristics :

	Characteristic No.
Working rhythm	420 *)
Quality of job performance	421
Independence and initiative	422
Responsibility	423 *)
Resistance to stress and stamina	424
Adaptability to change	425 *)
Ability to cooperate	430
Capacity for leadership	431 *)

The third group (E 3) - "Sensory-motor characteristics" - consists of the following characteristics :

	Characteristic No.
Powers of reaction	440
Manual skill	450
Bodily skill	451

*) These characteristics do not appear in the catalogue of characteristics. See chapters 3.3.1 and 4.3.3

Strictly speaking, powers of reaction are not a uniform characteristic; basically a distinction should be made between reaction speed, multiple reaction to complex stimuli and considered reaction; this could easily be done in the context of the question concerning corresponding aptitudes. On the requirement side, this differentiation is not possible so easily so that for reasons of expediency the characteristic has been summarized in the present form.

The fourth group (E 4) - "Other psychological characteristics" - also considers characteristics which are important to requirements and aptitudes but for which there is no general classification criterion; they include

	Characteristic No.
Powers of concentration	460
Endurance of monotony	461
Capacity for individual work	462

Each of these three characteristics is highly complex. On the requirement side it is therefore extremely difficult to show clearly the exact nature of what is required under the characteristic concerned at a particular workplace, as well as the necessary level of this characteristic. To interpret accurately the importance of these characteristics, the assistance of industrial psychologists is much more necessary than in the case of other psychological features. This is reflected in the fact that there is an extensive literature on the problem of monotony and the experts have been discussing this subject for many years. It would, however, not have been acceptable to omit this characteristic group because of the difficulties of interpretation. The characteristics listed here are in fact very important both from the aspect of ergonomics and job design and from that of suitability.

3.4 Differences from the maximal catalogue

As a result of the review of the maximal catalogue with the aims listed in 3.2, some of the characteristics initially chosen proved unsuitable for use in a profile comparison method - based on requirements and aptitudes. All characteristics which are of a descriptive nature on the workplace side but represent genuine requirements and therefore have corresponding aptitudes, are entered only once.

These include :

the individual characteristics such as expert knowledge, manual skill, responsibility, physical and psychological strain and environmental influences which are embodied in EULER; STEVENS' (11) job value index.

For the reasons already indicated in chapter 3.3.3, fluctuation frequency and performance characteristics which, as mentioned above, belong to the heading Descriptive characteristics, were deleted.

For similar reasons on the personnel side the following descriptive characteristics were omitted :

war and/or accident compensation, duration of employment with firm, wage levels, absenteeism, telephone number, accident frequency.

The main characteristic group "Physical characteristics" does not include special requirements - or more accurately conditions at the workplace which may have consequences on the physical constitution of the employee - for which there is no corresponding aptitude . Examples are danger to the eyes, risk of cold.

The initially highly differentiated requirements on the function of fingers, hands and feet were summarized in a single characteristic (see characteristic 230) because even a very accurate classification could not do justice

to individual peculiarities in the event of a reduction in earning ability. Here the doctor must give his opinion after the pre-selection process (see chapter 2.3).

The summary of the initially large number of characteristics in the environmental influences main characteristic group into a relatively small number of characteristics was necessary for practical reasons. A large number of medical examination values were also not taken from the maximal catalogue because here direct comparisons of requirement and aptitude characteristics are not possible. This includes for example

- results of examination of the spinal column, motor and sensory nervous system, urine tests.

In accordance with the aims of the research project,

- occupational desiderata, present and future development possibilities, promotion plans and so on

were not included as these criteria can only be indicated in the context of personnel planning measures based on an analysis of workplaces and staff.

The characteristics which are not included in the workplace and personnel information system (API) developed for this project can of course be incorporated in an industrial information system if the aim of the system so requires. The general limitation to the characteristics which correspond to the aims of the project was necessary on the one hand for practical reasons to test the analysis method, and on the other to delimit the problems in relation to other partial areas of industrial personnel management. Depending on the problem, a great deal of information is needed in the enterprise in order to find an optimal solution to the set questions. A large part of this information is required in several sub-areas of the enterprise so that it seems desirable to store all this data - including items required in a workplace and personnel information system - in a management information system.

4. TESTING THE CATALOGUE OF CHARACTERISTICS IN INDUSTRIAL STUDIES

4.1 Aims of the tests and procedure

The primary aim of the tests of the catalogue of characteristics initially designed on a theoretical basis was to determine the practical applicability of the survey instruments. A critical appraisal was made of the following criteria :

- time and personnel required to collate the data
- qualifications of data-collating personnel
- clarity and meaningfulness of the characteristic and grade definitions.

The studies were also intended to show the extent to which the relevant data is available in the enterprise and the methods which must be applied to acquire missing data.

The general procedure in the industrial studies is explained below. Because of the different nature of the workplace and personnel data the practical studies were divided into two parts :

- acquisition of workplace data
- acquisition of personnel data.

The actual data acquisition process was preceded on the workplace side by determination of the workplaces to be studied and on the personnel side by the choice of personnel working at the relevant workplaces. In general this choice consisted of a selection of one or two shift members in the area concerned. The two study sections, workplace data acquisition and personnel data acquisition, were then treated largely independently, being carried out either by different study teams at the same time or by the same team successively. A study team generally consisted of two scientific staff members of the FIR.

Because of the varying availability of the data material, determination of workplace data required a series of different methods which are shown in figure 10 - arranged by their application to the individual data groups.

			Main characteristic groups				
			A	B	C	D	E
1	Evaluation of job description etc.		X	X			
2	Interview method		X	X			X
3	Classification by observation				X	X	X
4	Evaluation of measurement results	existing			X	X	
		specially determined				X	

Fig. 10 : Methods of acquiring workplace data

A distinction of principle must be made in this connection between the methods of evaluation of data already available in the enterprise (1 and 4) and the methods which involve determination by the survey team of data which is not already available (2 and 3).

By evaluating industrial work description (e.g. workplace and job descriptions), it was generally possible to acquire most of the data for the main characteristic group A (General characteristics); only for characteristics 14 (Decision making authority) and 18 (Duration of training/instruction) was no information available so that the data on these items had to be obtained by the interview method described below.

In the interview method the study team determined the necessary data in a conversation with the appropriate hierarchical superior, e.g. foremen, supervisors, works managers and the appropriate works Council representatives - generally referred to below as works experts. In the case of

workplaces which were only individually occupied or covered a highly specialized area, the employees concerned were also interviewed directly in the presence of a works Council representative. To determine the data in main characteristic group B (Knowledge characteristics) the interview method was also suitable since little detailed information was available from the work and job descriptions on the necessary school and occupational training (characteristics 100-106), occupational experience (111-116), evidence of aptitude (170-172) and knowledge of foreign languages (181-183). More detailed information from the works experts was necessary in particular on questions concerning the occupational experience necessary at the workplace. The purpose of this information was to give an indication on individual career models, i.e. detailed information on the workplaces at which experience is required.

The interview method was also used to acquire data in main characteristic group E (Psychological characteristics) in cases where the working areas of the workplaces under study were very large and the activities to be performed varied and irregular, e.g. in the case of maintenance work. At these workplaces it was not possible to ascertain all the characteristic data by personal observations during the activities. For this reason the observations of the research team had to be confined to a thorough inspection of the workplaces characteristic of the activity concerned at which the employee was primarily active and/or at which special requirements of a mental, physical or psychological type occurred; the individual characteristics were then graded jointly in discussions with the works experts.

For workplaces with practically stationary activities, e.g. first melter, rolling train operator or control station supervisor, a method involving classification by observation seemed most suitable for acquiring data in

main characteristic groups C, D and E (physical characteristics, environmental influences and psychological characteristics), when no measurement results were available. In this method, the research team observed the activities at the individual workplaces several times per shift at irregular intervals, obtained further information on special features, peak loads or fault frequency at the workplace from superiors and/or the employee himself and classified the characteristics for the workplace concerned.

To check the accuracy of the classification, for a few workplaces measurement results for job strenuousness (work calories, working pulse frequency, climatic and noise stresses) were compared with the values estimated by the research team. As the estimated values always lay in the dispersion range of the measured values, and the three stage characteristic classification allowed some dispersion, the estimates were considered sufficiently accurate for the purpose in hand. To ensure comparability between the estimated data, the membership of the team making the estimate was held as constant as possible.

A similar comparative test was also organized for the psychological characteristics in main characteristic group E in which the characteristic classifications made by the industrial psychologist at an agreed workplace were compared with those of the research team and general concordance was noted. Further classifications were then made by the research team after consulting the psychologist or other works experts on doubtful matters.

A further method of ascertaining the physical workplace requirements and environmental influences was the evaluation of existing measurements or measurements specially carried out. This was the case essentially with data on job strenuousness, noise and climatic stress made available by the enterprise or recorded by the research team itself. The operational data was taken from the analytical job evaluation documentation in the

case of data determined by recognized measurement methods, e.g. on job strenuousness, climatic and noise stresses or factors which could be clearly determined such as bodily posture (characteristic 210), function of the limbs (230), ability to wear a mask (241), skin stresses (310) and so on.
A general incorporation of all the data relevant to characteristics from work evaluation documentation, especially on the psychological requirements listed, was not planned - for the reasons mentioned earlier - and would in any case have been partly impossible for methodological reasons.

The evaluation of the measurements made by the research team itself related to climatic and noise measurements in two research areas. To gain the fullest possible impression of climatic and noise stresses at the workplaces, measurement points were fixed throughout the research area at places where either high loading occurred or at which the employees concerned spent long periods.

The measurements were made during activities typical to the place concerned and sometimes repeated several times in a shift; for each workplace or employee to be studied, the duration of the stay at the individual measuring points was then estimated and a mean climatic or noise load per shift determined. If very high loads occurred at relatively infrequent intervals, e.g. loads for two hours each week when cleaning the mixer inlet in the steelworks, these peak loads were decisive in determining the overall load, although they would not have been taken into consideration in calculating the shift average. However, as the methods described involved a considerable employment of staff and equipment and consequently impeded to some extent normal working in the areas under investigation, the estimation methods referred to above were adopted for the other study areas. These methods were adequate for the trial purpose but exact measurements will be essential if the characteristic catalogue is to be used later under operational conditions

for personnel planning purposes.

To ascertain personnel data a division was made into three research sections (fig. 11) :

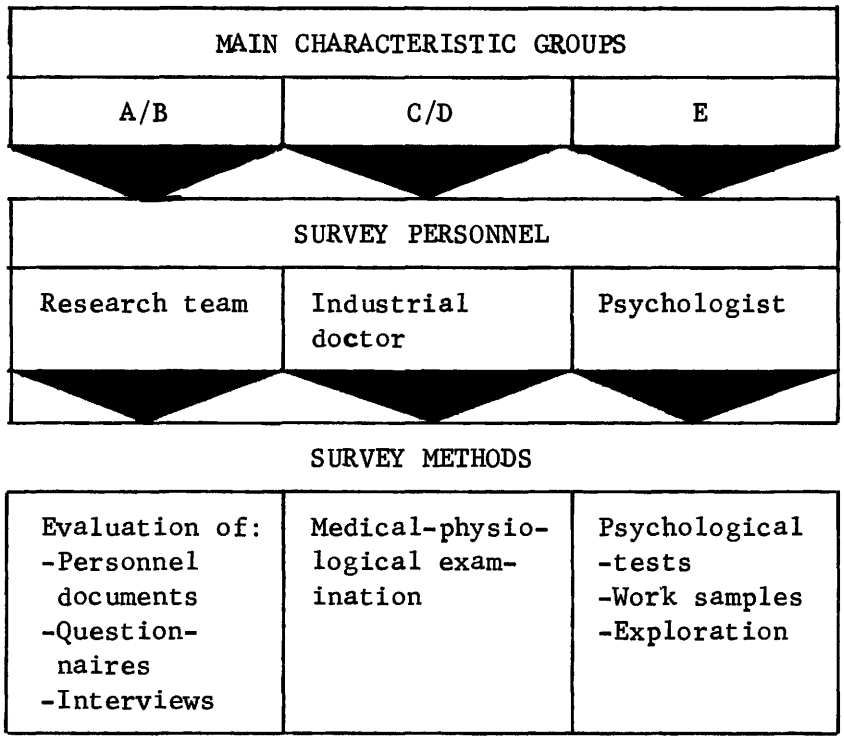

Fig. 11 : Methods of ascertaining personnel data

1) Acquisition of data on main characteristic groups A and B by the research team

2) Acquisition of data on main characteristic groups C and D by the industrial doctor

3) Acquisition of data on main characteristic group E by the psychologist.

Data on main characteristic groups A and B was ascertained by the research team with the aid of three separate survey methods. Evaluation of personnel documents was the normal procedure and only when this was impossible or the information was not sufficient was data acquired with questionnaires or interviews.

The questionnaire developed for this purpose[1] contained questions on schooling and occupational training, career in the enterprise and elsewhere and on courses and other further training measures. The association of indications given by personnel with the data acquired on the workplace side was effected through the workplace designation and workplace number which was clearly determined by adding a further digit in the case of multiple occupation of the workplace. As a result the recording of personnel data was practically anonymous as neither the name nor the individual number needed to be mentioned.

The personal conversation with an employee took considerably more time than a questionnaire system but offered the advantage that detailed information could be requested on the subjects of occupational experience and further training measures from which additional knowledge, i.e. knowledge not or not fully used in the present workplace, could be determined. This data is particularly necessary - in conjunction with information on additional aptitudes determined by the doctor and psychologist - for rational qualitative personnel planning.

To determine the physical and psychological aptitudes referred to above, personnel survey sheets[2] were developed based on EGGELING's method (10), which enabled the research worker to mark boxes on a form without complex coding of characteristic stages in order to define certain limitations on the physical or psychological stress capacity of the employee concerned.
To withhold the confidential information on the survey forms from unauthorized persons a method was developed in which the doctor or psychologist merely forwarded to the personnel department a copy form on which only the personnel number and crosses appeared. This form used as a punched record is designed in such a way that the information entered on it can easily be coded or punched

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1) See Annex 8.2.1, page 46

2) Personnel study form No. 6 (Medical examination) and No. 7 (Psychological examination) with the corresponding punched records.
See Annexes 8.2.5 - 8.2.8, pages 50 - 53

directly in order to safeguard the anonymity of the information. If a clear type reader is available this data can also be transferred directly onto an EDP system.

4.2 Selection of study areas and data acquisition

Before selecting suitable study areas to test the catalogue, a preliminary study was carried out in nine works where the research team discussed the state of information on workplace and personnel data as well as the validity and availability of this data with appropriate enterprise representatives such as personnel managers, industrial doctors, industrial psychologists, works counsellors, and works scientists.

In addition, a general impression was gained of the working areas in the iron and steel industry so that it was possible after the preliminary study, in agreement with the project Council, to define the scope of the following surveys as four typical areas for this branch of industry :

research area	blast furnace
"	steelworks
"	rolling mill
"	maintenance

The blast furnace research area covered a blending plant, sinter plant, melting works and yard operation; the steelworks was an oxygen steelworks (LDAC) with mixer, converter, rough casting, continuous casting department, yard operation and crane installation for these areas. The rolling mill not only covered the production area of a blooming mill as such with handling, rolling and finishing operations but also related areas such as roll grinding, material handling, quality control, final acceptance, loading and machine operation including crane work, machine attendance etc. but not maintenance.

Because of the large number of workplaces in the overall maintenance area, a representative selection had to be made for the maintenance study in which all individual areas such as mechanical and electrical maintenance, workshops, building work and maintenance of energy and thermal plant were included. Further selection criteria were works areas such as blast furnaces, steelworks and rolling mills in which the corresponding maintenance personnel was engaged.

Studies in four enterprises named by the Council covered a total of 241 different workplaces and 519 employees whose distribution between the study areas is shown in figure 12.

Study area	Workplaces			Personnel		
	Skilled workers	Supervisors technicians	Total	Skilled workers	Supervisors technicians	Total
Blast furnace	36	6	42	99	6	105
Steelworks	54	7	61	174	7	181
Rolling mill	60	9	69	155	9	164
Maintenance	54	15	69	54	15	69
		$\sum AP = 241$			$\sum P = 519$	

Fig. 12 : Summary of workplaces and employees covered.

Except in the case of the maintenance workplaces, several employees (generally a maximum of two shift crews) were chosen for the skilled workplaces. In the case of the supervisors and technicians included in the study, only one workplace occupant was selected in each case because of the single manning. The reasons for including supervisors and technicians who do not belong under the heading of skilled workers and were generally shift foremen and shift technicians are as follows :

1) The working area of the shift foreman and his subordinate staff is an operational and local unit to which the shift technicians also belong.
2) The inclusion of supervisors and technicians afforded the opportunity of also covering workplaces with activity functions from the white collar sector (e.g. recording, classifying, determining processed data and work processes, managing staff, calculating). In this way the possibility of extending the catalogue of characteristics to white collar activities could be examined.

On the workplace and personnel side data acquisition was effected with survey sheets designed for EDP[1)]. The structure of these sheets - with the exception of personnel survey sheets No. 6 and 7 referred to above - is such that the data entered by the study team previously coded with the aid of the catalogue of characteristics can be transferred directly onto punched cards in a punched card department. For this purpose a survey sheet was associated with each type of card, the upper screen block of which shows in each case in which columns of the screen or punched cards the individual characteristic data should be entered or punched. Figure 13 shows a screen block of this kind for the workplace survey sheet No. 3.

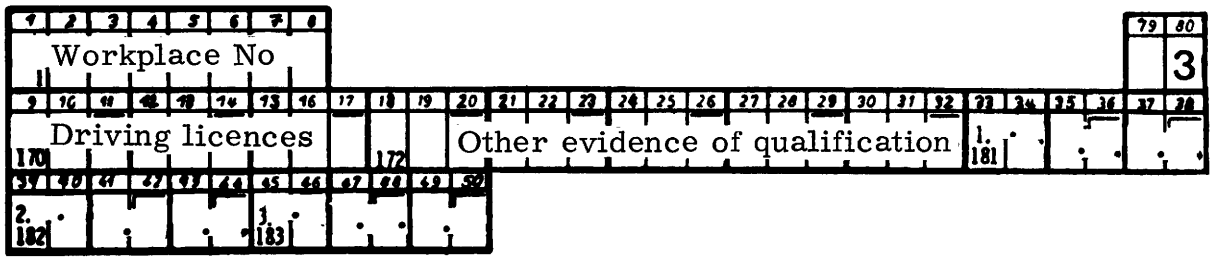

Fig. 13 : Screen block for workplace survey sheet No. 3

The data fields available for the characteristics are defined by the characteristic designations or by abbreviations or symbols for the latter, and by the characteristic number in the lower left corner of the data field.

1) Workplace survey sheets Nos. 1 to 5 and personnel survey sheets Nos 1 to 7. See Annexes 8.2.1 and 8.2.8, page 47 ff.

If a priority is to be indicated in the workplace data, the code figure for the corresponding priority stage (see priority code Annex 8.1, page 2) is appended to the code figures for the corresponding characteristic; e.g. in the case of characteristic 170 (Driving licences) with two digit code figures, columns 11, 14 and 17 are intended for priority information. For recognition purposes the corresponding fields have a horizontal evaluation (see chapter 3.3.4.2) in the profile comparison are also given a down stroke on the left of the horizontal line as is the case in columns 36 and 38 of the screen block.

In the personnel survey sheets the surname, given name, place of residence and street are entered in clear text; all other characteristic data is coded in the same way as the workplace data. The personnel survey sheets No. 6 (Medical examination findings) and No. 7 (Psychological examination findings) which correspond to the workplace survey sheets No. 4 (Physical requirements and environmental influences) and No. 5 (Psychological requirements) were already described in chapter 4.1.

4.3 Experience gained from enterprise studies and consequences for the survey

4.3.1 Time and personnel requirements for the survey

From the standpoint of practical applicability of the survey instruments, the extent of the time and personnel required is of great importance. The enterprise studies gave initial values on this point which are briefly interpreted below.

The varying nature of the organizational, personnel and local structures which had a not inconsiderable influence on the overall study period in the individual research areas, makes it difficult to indicate generally valid values for the time required to ascertain workplace and personnel data. This is easiest on the workplace side because the course of the studies was much the

same, apart from the often lengthy preliminary discussions to clarify the peripheral conditions of data acquisition. A rough indication for the time requirement in a workplace data survey can be arrived at as follows :

$$t_{m;\ AP} = \frac{\sum_{i=1}^{n} \frac{T_i}{m_i}}{n}$$

in which

$t_{m;\ AO}$ = mean value for time required to acquire data at a workplace

T_i = overall time to acquire workplace data in study area i

m_i = number of workplaces covered in research area i

n = number of research areas

with T_1 = 2 weeks . 40 hours/week = 80 h; m_1 = 42 AP (AP = workplaces; H = hours

T_2 = 3 weeks . 40 hours/week = 120 h; m_2 = 61 AP

T_3 = 3 weeks . 40 hours/week = 120 h; m_3 = 69 AP

T_4 = 2,5 weeks . 40 hours/week = 120 h; m_4 = 69 AP

and n = 4

so that :

$$t_{m;AP} = \frac{\frac{80\ h}{42\ AP} + \frac{120\ h}{61\ AP} + \frac{120\ h}{69\ AP} + \frac{100\ h}{69\ AP}}{4}$$

$$t_{m;AP} = \frac{1,91 + 1,97 + 1,74 + 1,45}{4} = 1,77\ \frac{h}{AP}$$

A few additional observations on the basis of calculation for this value derived from experience of approximately 2 hours study time per workplace seem called for here :

1) The total time T_i only covers pure study time but not the time for preliminary discussions and preparatory organizational measures.

2) The value for $t_{m;AP}$ relates to four study areas with similar data structures, i.e. job descriptions and results of individual ergonomic measurements were generally available.
The reference value $t_{m_{AP}}$ can only be transferred to enterprises structured in this way.

3) $t_{m;AP}$ is applicable for data acquisition with a team of on average two persons. It does not seem desirable to relate $t_{m;AP}$ to one person as a team size of two men appears favourable and generally also necessary in the studies. The reasons for this will be examined later.

It should also be noted that the survey time $t_{m;AP}$ may well be shorter than the calculated experience value when the data is acquired by a survey team internal to the enterprise which is familiar both with the organizational and local structures and with the work sequence. The same applies to data acquisition for workplaces which are very similar to each other in which certain data groups are identical.
In the last resort the time required for the survey - this also holds good for personnel data acquisition - will always depend on the accuracy which the data is required to have. While estimation methods are generally no more than just sufficient in this connection, the time required for the survey will increase when more complex measurement methods are used.

Calculation of a corresponding reference value for personnel data acquisition is much more difficult as only some of the characteristics were covered by the research team and only general estimates were available of the actual time required for the medical and psychological examination. For the parts of the characteristics covered by the research team (main characteristic groups A and B)

an experience value can be indicated which is applicable both for the evaluation of the personnel documents and for the questionnaire and interview method :

$$t_{m;P1} \approx 0{,}5 \frac{\text{hours}}{\text{workplace occupant}}$$

($t_{m;Pj}$ = time requirement for personnel data acquisition for workplace occupants;
j = 1 = main charact. groups A and B,
j = 2 = " " " C and D,
j = 3 = " " " E)

It is assumed that the data is ascertained by a single research worker.

The time required to ascertain physical aptitudes (main characteristic groups C and D) is estimated by the industrial doctors as

$$t_{m;P2} \approx 2{,}5 \frac{\text{hours}}{\text{workplace occupant}}$$

It should be borne in mind that this time may be reduced where examination findings are already available.

It is very difficult to arrive at a reference value for the time required for a psychological examination as many test methods have not yet been standardized and the duration of the individual tests varies widely. The industrial psychologists indicate as a minimum :

$$t_{m;P3} = 2 - 3 \frac{\text{hours}}{\text{workplace occupant}}$$

the higher value applying to individual examinations and the lower to examinations where some of the characteristics are determined in grouped tests.

Addition of the experience or estimated values for personnel data acquisition then gives

$$t_{m;P} = \sum_{j=1}^{3} t_{m;Pj} = 5 - 6 \ \frac{\text{hours}}{\text{workplace occupant}}$$

The personnel required to carry out the examinations was generally two men on the workplace side, this team strength proved particularly favourable and also necessary for the following reasons :

1) Because of the possibility of disturbing or impeding the working operations at certain workplaces, a team of more than two persons would have been unfavourable.
2) As with the present data structure in the enterprise some of the data has to be acquired by estimation methods (see also methods of data acquisition, chapter 4.1) and comparability between this estimated data lessens with an increasing number of estimators covering different workplaces on a divided labour basis, the classification of workplaces in a self-contained area by a single person would be the most desirable solution. For the analysis of complex work sequences, however, one person is often not sufficient so that support by a second is necessary. In addition, the time saving and possibility of mutual support and joint discussions of problems and classification militate in favour of a two-man team.

On the personnel side the strength of the survey team concerned solely with ascertaining data on the main characteristic groups A and B is less limited. Since for the purposes of ascertaining this data, a division of labour on the basis of quantity is possible, i.e. the number of workplace occupants for whom data must be ascertained can be distributed between the team members,

the size of the team can be adapted to the extent of the work.

The qualification requirements on personnel employed when the survey instruments are used in the works can only be described with difficulty with standard designations such as works study expert, REFA engineer or ergonomist because of the novelty and complexity of the area. A list of the areas in which the members of a team engaged in workplace data acquisition should have knowledge or experience gives a clearer impression of the actual requirements :

1) Organizational and local structure of the sector examined (works, enterprise)
2) Rough outline of process and work sequence
3) Industrial training, further training and advanced training
4) Principles of work study, in particular methods of workplace description and ergonomic workplace design
5) Principles of ergonomic measurements
6) Principles of physical and psychological job requirements.

An identical qualification in all these areas is not absolutely necessary for the members of the team; practical training and experience in one profession in the branch concerned would, however, be desirable.

The requirements placed on the team for personnel data acquisition in respect of main characteristic groups A and B are not as extensive as on the workplace side because of the limited areas involved and extend to the knowledge of the personnel area with its organization and data structure. Staff of the personnel department would therefore be well-suited to membership of such a team. With a view to increasing cooperation between the personnel and EDP departments, staff of the latter department - especially when a personnel data bank exists or is planned - would be suitable or often indeed necessary for cooperation in a team.

In order to keep the additional burden on the industrial medical and psychological service in the acquisition of data as low as possible, the possibility should be examined of utilizing independent medical or psychological assistance for parts of these studies. After appropriate training and special courses, it should be possible for certain more or less standardized medical examination processes such as the determination of amplitude pulse frequency or performance pulse index with the aid of a bicycle ergometer, measurements of brief peak loads with the aid of a dynamometer, determination of visual acuity or colour recognition to be carried out by such staff (e.g. female medical-technical assistants).

For the psychological service directives are available on the delegation of partial tasks to appropriately trained assistants (68).

4.3.2 Experience and problems in using the catalogue of characteristics

In line with the purpose of the trial, critical appraisal and possibly improvement of the characteristics and grade definitions was a constant aim.

Special attention was given to the grade definitions for psychological characteristics, the formulation of which had to correspond to exact grade level. It was not always possible to find uniformly valid grade definitions of all the workplaces studied; for this reason, several alternative definitions were sometimes given for a particular grade, e.g. for characteristics 400 (stages 2 and 3), 410 (stage 2) and 424 (stage 3).

The indication of examples intended initially only to supplement grade definitions proved indispensable for the psychological characteristics and was taken as an essential component of the grade definitions. For

the final version of the catalogue of characteristics, the examples were therefore selected from the workplaces in the iron and steel industry covered in the industrial studies, workplaces of both skilled staff and shift supervisors as well as technicians being included. The compilation of the examples for the individual characteristics can be considered as an approximate priority series in which no further differentiation was effected within the characteristic stages. As far as possible, four examples were indicated for each stage of the psychological characteristic (one example per study area)[1)]. The compilation of a more precise priority series was not possible in the context of this project as the requirements of similar or identically named workplaces were not entirely comparable because of differences between the enterprises studied. A priority series of this kind can only be drawn up for individual enterprises because of the special features of each undertaking which always exist, attention being given from time to time to the necessary updating of the priority series, e.g. due to constant technological change and accompanying changes in the requirements.

With reference to the group of supervisors and technicians, experience in the industrial studies showed that the requirements of these workplaces at which part of the work consists of white collar activities, could be covered by the survey instruments described here. A further extension of the catalogue of characteristics to workplaces in which white collar activities predominate appears possible in principle in the light of the study experience. However, it would be necessary to redesign the catalogue for this purpose by re-arranging and re-formulating the characteristics in regard to the specific requirements of these workplaces. The acquisition of corresponding personnel data which would relate in the case of this personnel to an even greater extent than in the previous studies to psycological characteristics, might, however, be difficult as even in the studies already carried out

there was only partial success in acquiring data on the psychological characteristics. The psychological and to some extent also the industrial medical services are largely overburdened with their present personnel capacity so that they could not carry out such extensive examination which would have to cover an entire enterprise or works area if the catalogue of characteristics was later used more widely. In addition to the overloading of the medical and psychological services, resistance by works counsellors to medical and psychological examination may also make the acquisition of personnel data much more difficult.

Resistance of this kind probably results from the failure to recognize that personnel planning covering the interests of each individual staff member cannot be successful without knowledge of data of this kind and that the comprehensive and timely consideration of human interests is only possible where appropriate personnel data is available.

Because of these difficulties, complete personnel data was only acquired in a few cases in the industrial studies carried out here. Promises to supply medical and psychological personnel data after our studies were completed were only met to a very limited extent. However, it seems in the light of some examples of personnel data that the instruments developed could be used in practice once the difficulties mentioned above have been removed.

One of the most important criteria for the practicability of the survey instruments is, as mentioned already elsewhere, the time required for data acquisition. As the total time for workplace and personnel data acquisition was very high in the studies, an attempt had to be made to reduce the survey requirements to a reasonable level. The measures taken jointly with others for this purpose are dealt with in the next section.

4.3.3 Consequences for the survey instruments

Experience gained in the industrial studies showed that a few characteristics could be removed from the guidelines drawn up from the studies for the reasons indicated above. In accordance with the requirement for a reduction in the time needed for the survey it was therefore possible to delete or replace certain characteristics. Of the eight characteristics in all which were deleted and no longer appear in the catalogue of characteristics, two previously appeared in the "General characteristics" main characteristics group :

repetitive or alternating tasks
group work

and the others in the "Psychological characteristics" main characteristics group :

organizing and arranging ability
estimating distances and movement
working rhythm
readiness to assume responsibility
adaptibility to change
capacity for leadership

The reasons for deleting these characteristics are indicated below.

The information provided by the "repetitive or alternating tasks" characteristic which as an exclusively workplace descriptive characteristic could not appear in the profile comparison, is largely also given by the endurance of monotony characteristic (No. 461), which appears both as a psychological requirement and as an aptitude characteristic in the profile comparison; the level at which endurance of monotony is required also indicates the extent to which an activity is repetitive. Deletion of this characteristic therefore avoids unnecessary duplication.

The same applies to the "group work" characteristic, information under

which coincides largely with the "ability to cooperate" (No. 430) and "capacity for individual working" (No. 462) psychological characteristics.

The "organizing and arranging ability" characteristic was delected for the following reason : the requirements made of skilled workers in respect of organizing and arranging ability are relatively small with a few exceptions. Moreover, experience in the industrial studies showed that the information obtained on the characteristics "perceptive ability" (No. 400), "practical skills" (No. 401) and "independence and initiative" (No. 422) is generally sufficient to characterize adequately the organizing and arranging ability in respect of the set requirements or existing aptitudes for the workplaces and personnel studied. A further reason for deleting the characteristic was the difficulty of ascertaining with a reasonable effort, a corresponding ability on the personnel side.

This is also true to an even greater extent for the three other psychological characteristics "responsibility", "leadership ability" and "adaptability to change" in the case of which it is possible to formulate and estimate the requirements on the workplace side while - according to industrial psychologists - it is relatively complicated to ascertain corresponding aptitudes on the personnel side. Acceptance of these three characteristics would for instance have increased the time required for a psychological examination by two to three hours. However, in filling certain workplaces at which these abilities are required to a significant extent it would be worth considering whether the capacity of the applicant or applicants in respect of these characteristics should be checked in special tests extending over a long period.

The "estimating distances and movements" characteristic was deleted completely from the catalogue because it was found in the industrial studies

that this characteristic was extremely dependent on practice and special experience. The indispensable physiological requirements are ascertained on the workplace and personnel side under the characteristic "spatial vision and uninterrupted field of vision" (No. 221).

When work is not cyclical it is frequently not possible to determine clearly the exact "working rhythm" required at the workplace as it is extremely difficult to obtain an objective definition of the requisite working rhythm. This characteristic was therefore deleted from the catalogue, especially as the majority of activities in the iron and steel industry are performed without a direct cyclic obligation.

By combining the two characteristics "verbal" and "written powers of expression" in a single characteristic (Nos 414/415) the catalogue was tightened up further. Industrial studies had shown that the requirements for verbal and written powers of expression are closely correlated in the area studied. On the personnel side both abilities will continue to be examined and they will then be jointly assigned to a single characteristic grade.

If the catalogue of characteristics were extended to office activities, some of the characteristics deleted or replaced here may have to be reconsidered.

For subsequent practical purposes it may also have to be considered whether the activity functions described in chapter 3.3.3 (characteristic No. 10) should be classified as supplementary indications relating to the professional experience characteristics. The additional characterization of earlier activities of a staff member by activity functions gives a description - which is not dependent on the traditional occupational activity designation - of the functions actually performed and therefore allows a better assessment of the experience acquired with

Main characteristic group	Characteristic group	Charact. number	Characteristic: Designation of characteristic	Number of alpha-numeric symbols: Workplace side	Personnel side
A General characteristics	A 1 General workplace data	1	Workplace No.	8	
		2	No. of identical workplaces	2	
		3	Designation of workplace	4	
		10	Activity categories	15	
		11	Enterprise and work sector	4	
		12	Inferior post	16	
		13	Superior post	3	
		14	Decision-making authority	1	
		17	Degree of movement	1	
		18	Training/experience	1	
	A 2 General personnel data	30	Individual number		6
		31	Name		30
		32	Nationality		2
		33	Address		48
		34	Family status		1
	A 3 General comparison characteristics	60	Sex	2	1
		61	Age	3	6
				Σ 60	Σ 94
B Knowledge characteristics	B 1 Schooling and technical training	100	Schooling	2	1
		105	Occupational category (training)	5	4
		106	Training level	2	1
	B 2 Occupational experience	110	Beginning of present activity		4
		111	Workplace number	18	40
		112	Enterprise and work sector	10	20
		113	Relevance of experience to sector	4	5
		114	Occupational category (experience)	10	20
		115	Level (experience)	4	5
		116	Duration	6	10
		118	And/or	1	
	B 3 Further and advanced training	170	Driving licences	9	6
		172	Other evidence of qualifications	15	10
		181 - 183	Knowledge of foreign languages	18	12
				Σ 104	Σ 138
C Physical characteristics	C 1 Muscular stress	200	Muscular effort	2	1
		201	Brief peak load	2	1
	C 2 Bodily posture	210	Bodily posture	4	4
	C 3 Vision and hearing	220	Visual acuity	2	1
		221	Spatial vision	2	1
		222	Colour vision	2	1
		226	Hearing power	2	1
	C 4 Function of members	230	Function of members	4	2
	C 5 Other physical characteristics	240	Alternating shift	1	1
		241	Fitness for wearing mask	2	1
		242	Freedom from giddiness	1	1
		243	Sudden occurrence of shock	1	1
				Σ 25	Σ 16
D Environmental factors	D 1 Climate, noise	300	Climate	2	1
		301	Noise	2	1
	D 2 Dirt, water, chemicals	310	Stress on skin	2	1
		311	Stress through dust... in the air	2	1
	D 3 Effects of mechanical vibrations	320	Whole body vibrations	2	1
		321	Hand/arm system vibrations	2	1
				Σ 12	Σ 6
E Psychological characteristics	E 1 Mental characteristics	400	Perceptive faculty	2	1
		401	Practical skill	2	1
		410	Technical understanding	2	1
		412	Powers of observation	2	1
		413	Mathematical skill	2	1
		414	Oral/written powers of expression	2	1
		417	Spatial perception	2	1
	E 2 Working and social behaviour	421	Quality of job performance	2	1
		422	Independence and initiative	2	1
		424	Resistance to stress and stamina	2	1
		430	Ability to cooperate	2	1
	E 3 Sensory-motor characteristics	440	Powers of reaction	2	1
		450	Manual skill	2	1
		451	Bodily skill	2	1
	E 4 Other psychological characteristics	460	Powers of concentration	2	1
		461	Endurance of monotony	2	1
		462	Capacity for individual work	2	1
				Σ 34	Σ 17
				ΣΣ 235	ΣΣ 271

Fig. 14 : Summary of characteristics and alpha-numeric symbols required

reference to the experience needed at a particular workplace.

Figure 14 gives a general summary of the structure and number of characteristics which were eventually included in the catalogue of characteristics as well as the number of alpha-numeric symbols required for each characteristic. The definitions of the individual characteristics and the associated grades or codes will be found in Annex 8.1 to this report.

5. REQUIREMENT AND APTITUDE DATA IN A WORKPLACE AND PERSONNEL INFORMATION SYSTEM

5.1 Methods of evaluating requirement and aptitude data

5.1.1 Aims of the evaluation programmes

The aim of evaluating requirement and aptitude data is to arrange systematically the data outlined in chapter 3.3 to solve personnel planning problems and make this data available in an operational manner for planning purposes (see chapter 1.3). Unlike many operational personnel utilization models, the point of departure is not the maximization of production or minimization of working time (see PAPE and SCHÖN 47, page 152; FRANA 16, page 216), but essentially to make the full use of personnel aptitudes (see MENSCH 42, pages 488-492). Unlike the industrial economic utilization models, personnel utilization planning based on aptitudes only leads to cost minimization as a secondary consideration.

Six essential aims can be formulated :

1) Analysis of present utilization of personnel
2) Occupation of a workplace by a suitable employee
3) Selection of a suitable workplace for a particular employee
4) Personnel employment plans in the development of new works
5) Statistics and index calculations
6) Development of profile groups for long-term personnel planning from the results of which the necessary planning measures can be derived for personnel requirement assessment, personnel procurement, personnel development, personnel utilization, personnel retention or personnel release, as well as the measures for ergonomic workplace design.

For both the ergonomic and other functions of personnel management, the degree of detail of the evaluation plan depends on the chosen planning horizon, i.e. it is sometimes necessary to clarify whether short, medium

or long-term measures should be taken. To ensure continuous planning it is necessary to take as the starting point identical basic programmes for all planning periods which can then be varied according to the special objectives. The profile comparison was selected as a practicable method in chapter 2.3 in order to derive the necessary measures from the existing or forecast concordance, overlap or underlap.

5.1.2 Comparison of requirements and aptitudes by the profile method

In carrying out and evaluating the profile comparison, it was assumed, for the reasons already indicated in chapter 2.1, that the necessary data storage and processing would be effected with an EDP system. The computer programme developed for this purpose whose position in the workplace and personnel information system is discussed in chapter 5.2.2.3, is described below with reference to the procedure :

The profile comparison programme is in principle structured in two sections

- graphic profile presentation
- numerical profile evaluation

In the first section the requirements of the workplace and the aptitudes of the staff member are compared and expressed in a clear form (see figure 18.1, page 123). A detailed description of this graphic profile presentation is effected in conjunction with an application example in chapter 5.3.2.

However, if a fairly large number of profiles are to be compared it is difficult to obtain an overall picture of the many graphic profile comparisons. A numerical evaluation of the comparison data is therefore effected in the second section of the programme in which the individual characteristic comparisons are arranged and compressed in the following evaluation steps :

1) Compilation of knowledge not required at the workplace
2) Compilation of profile underlapping
3) Compilation of profile overlapping
4) Calculation of deviation indexes for each main characteristic group and
5) Calculation of a total deviation index.

As it is in the interest both of the enterprise and of the staff to use the available aptitude potential optimally, the existing knowledge of the staff which is nut usable at the particular workplace is shown in the first stage (see JACOB 31, page 228).

Limitation to the group of knowledge characteristics seemed desirable as the biggest reserves are probably available under the knowledge and experience headings.

The profile underlappings - arranged by priority figures and grade differences - are then listed. In order to cover specifying characteristics as well (see chapter 3.3.4.1 "General structure of the characteristics") the numerical data to be compared is checked for uniformity. When the first deviation is found the number of digits still to be compared is ascertained and a value of 1 added to it. The number of uneven digits determined in this way is equated in the evaluation with the grade differences obtained for the graded characteristics. Depending on the operational importance of the individual specifying characteristics, weighting factors can be added.

Profile overlapping is shown in the same way. Calculation of deviation indexes - as the final stage in information compression - is discussed separately in the next section.

5.1.3 Calculation of deviation indexes

In order to express the similarity of a requirement and aptitude profile in the context of a profile comparison with a single numerical indication, a formula was developed for calculation of a deviation index which represents the underlapping or overlapping of profiles.

Development of the formula was based on considerations put forward by LIENERT (39, page 464) who defines a profile similarity coefficient D as follows :

$$D = \sqrt{\sum_{k=1}^{n} (x_{kF} - x_{kA})^2}$$

in which :

k = serial number of characteristic

n = number of characteristics

x_{kA} = existing grade value of the requirements in characteristic k

x_{kF} = existing grade value of aptitude in characteristic k.

The coefficient D represents the geometrical distance between two n-dimensional profiles A (requirements) and F (aptitudes). MENSCH (42, page 490) completes the coefficient calculation for the comparison with minimum requirements by the peripheral condition :

$$x_{kF} - x_{kA} \geqslant 0.$$

If this dissimilarity does not apply, the minimum requirement is not met, in other words the requirements of the workplace are too high for the comparison subject in question. MENSCH (42, page 491) also sees the possibility of weighting the requirement overlaps according to their significance to the enterprise department. For this purpose he defines a weighted coefficient :

$$D_g = \sqrt{\sum_{k=1}^{n} g_k^2 \cdot (x_{kF} - x_{kA})^2}$$

in which g_k = weighting factor for overlap in characteristic k

Following on from this presentation a separate index calculation is effected in the profile method described here for underlapping and overlapping. In order to highlight significant profile deviations and avoid complex root extraction calculations, the square of the weighted distance described above is taken as the deviation index.
In so doing the priority indexes of the requirement characteristics were taken as the weighting factors. The following equations are therefore obtained for the deviation indexes :

Deviation index for profile underlapping :

$$AWK_u = \sum_{k=1}^{n} \left[PZ \times (x_{kF} - x_{kA}) \right]^2 \quad (PZ = \text{priority number})$$

Peripheral conditions : 1) $x_{kF} - x_{kA} < 0$ (Requirement underlapping)

2) $PZ < 3$ (Underlapping permissible only for priority numbers < 3)

Deviation index for profile overlapping :

$$AWK_u = \sum_{k=1}^{n} \left[PZ \times (x_{kF} - x_{kA}) \right]^2$$

Peripheral condition : $x_{kF} - x_{kA} > 0$ (Requirement overlapping)

To obtain a single figure as the profile similarity criterion, the overlapping index $AWK_{ü}$ is appended to the underlapping index AWK_u (see chapter 5.3.2).

This total deviation index is inversely proportional to a theoretical level of suitability obtained solely from the numerical evaluation of the profile comparison. As a series of very different characteristics is evaluated by a single scale in calculating the total deviation index, and compensation possibilities - especially in the case of psychological characteristics - can scarcely be taken into account, this index and the theoretical degree of suitability should only be taken as the basis for assessing the actual suitability, i.e. as a guide value for the pre-selection of matching individuals and workplaces. Further information must be considered - as already mentioned in chapter 2.3 - for the final decision on the assignment of an individual to a workplace.

5.2 Structure of a workplace and personnel information system

5.2.1 Theoretical design

The aims of data evaluation listed in the previous section can be achieved in the context of an information system which makes due allowance for the interests both of the workplace and of the staff. A workplace and personnel information system (API) of this kind must, according to DOMSCH (7, page 9), be a system for a complete and orderly acquisition, storage and evaluation of all relevant information on workplaces and personnel.
The following requirements must therefore be placed on an API :

1) Comprehensive and complete acquisition of all data relevant to the workplace and personnel
2) Systematic data storage allowing rapid and precise access
3) Comprehensive data evaluation facilities
4) Coupling with other data banks and information systems.

The structure of an API resulting from these requirements is shown in figure 15.

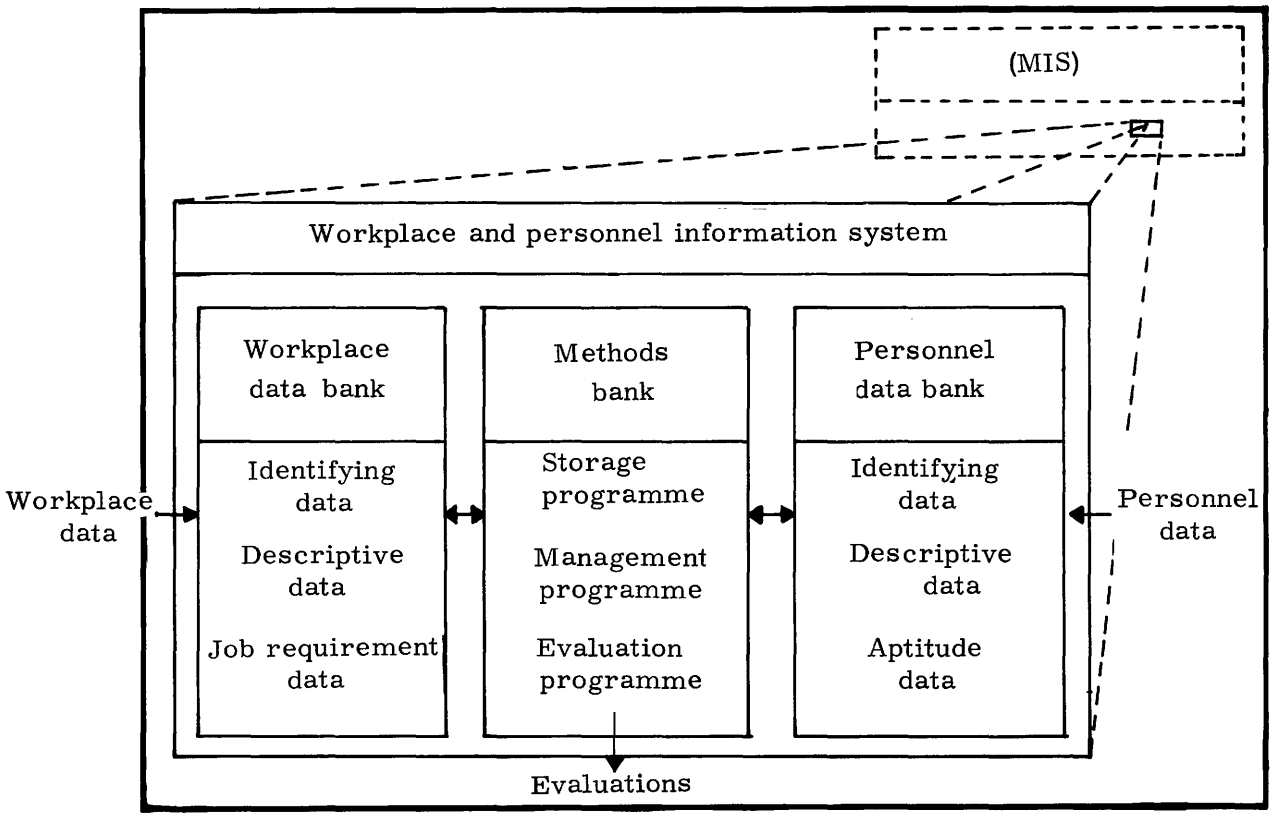

Fig. 15 : Structure of the workplace and personnel information system

Of the three data banks shown here, the workplace and personnel data bank forms the data structure for the API. The methods bank - the heart of the API - is a programme library from which extensive storage administration and evaluation programmes can be retrieved by fixed code words. In the evaluation programmes, the calculation of indexes, e.g. profile deviation indexes, is of special importance as they provide compressed information on the structure of the workplace and personnel data and therefore create the basis for integration of the API into a management information system (MIS) shown in figure 15, which (according to DOMSCH 7, page 8) also contains the finance, material management, production and marketing information systems as sub-systems.

The workplace and personnel data indicated in figure 15 provide the system input which is ascertained with the aid of the survey instruments described in chapters 3 and 4; the results of the evaluation programmes indicated in the illustration as "evaluations" provide the systems output. The API is structured in such a way that on the one hand extension of the data is always possible by additional data relevant to the enterprise while on the other some areas of the data indexes contained in the API can be evaluated also.

Working from this basic design, there are many possibilities for using the API in the industrial management process to achieve widely varying enterprise-specific objectives.

5.2.2 Technical implementation

5.2.2.1 Data input

The problems of data input in general are closely linked with the choice of the data carrier. Possible data carriers include punched tape and punched cards, supports which can be read optically and direct input on tape or disc.

Punched tape with its specific advantages of strength, easy, reasonably priced preparation and reading by a telex machine and simple storage cannot be considered as data supports for profile indications because of the impossibility of rapidly changing, deleting or supplementing items of information on the tape.

The punched card which meets the latter criterion as a special advantage is much more suitable for this purpose because of the possibility of making the punched information readable in clear script (composite punched

card). Finally the wide use of punched cards and devices for preparing and reading them makes them particularly suitable for use in this case. Magnetic tape is increasingly competing with punched cards. The high information density (approximately 200 times that of punched cards and 10 times that of punched tape), the associated price advantage (1/6 of the cost of punched cards (see ROHS 53, page 5)) and above all the high read-in speed is of benefit in data processing in comparison with punched cards. The fact that magnetic tape information can only be read with the aid of special instruments is an advantage as against composite punched cards when confidential information has to be stored in an API system. On the other hand this fact would be a real disadvantage in the trial stage when corrections have to be made rapidly and easily. Finally the possibility of taking over information recorded directly on punched cards by other companies was a decisive factor in their choice as the data support for workplace and personnel data. However, when the method is used operationally for data input purposes this does not exclude the use of other data supports, especially magnetic tape.

The data is punched on the cards according to the instructions given on the survey sheets designed for EDP purposes (see Chapter 4.2 and Annex 8.2). The first columns on the punched cards are reserved for the workplace or personnel number as classification and search criteria. As several cards are always required for each workplace or individual, a card type index is entered in the final column of each card as a further sorting criterion.

The space available for data on the punched cards (approximately 70 columns) is not fully used on the individual card type when punching workplace and personnel data; in this way a sufficient number of free columns are available if the data is subsequently extended or supplemented. In addition the

capacity could be considerably extended by introducing a two digit card index.

The workplace and personnel data fed into the central unit of an EDP system by a card reader should be checked carefully before storage because it is used as the initial data for a large number of evaluations so that wrong data may cause important secondary errors. For this purpose the data should be checked in two sections as shown in Figure 16.

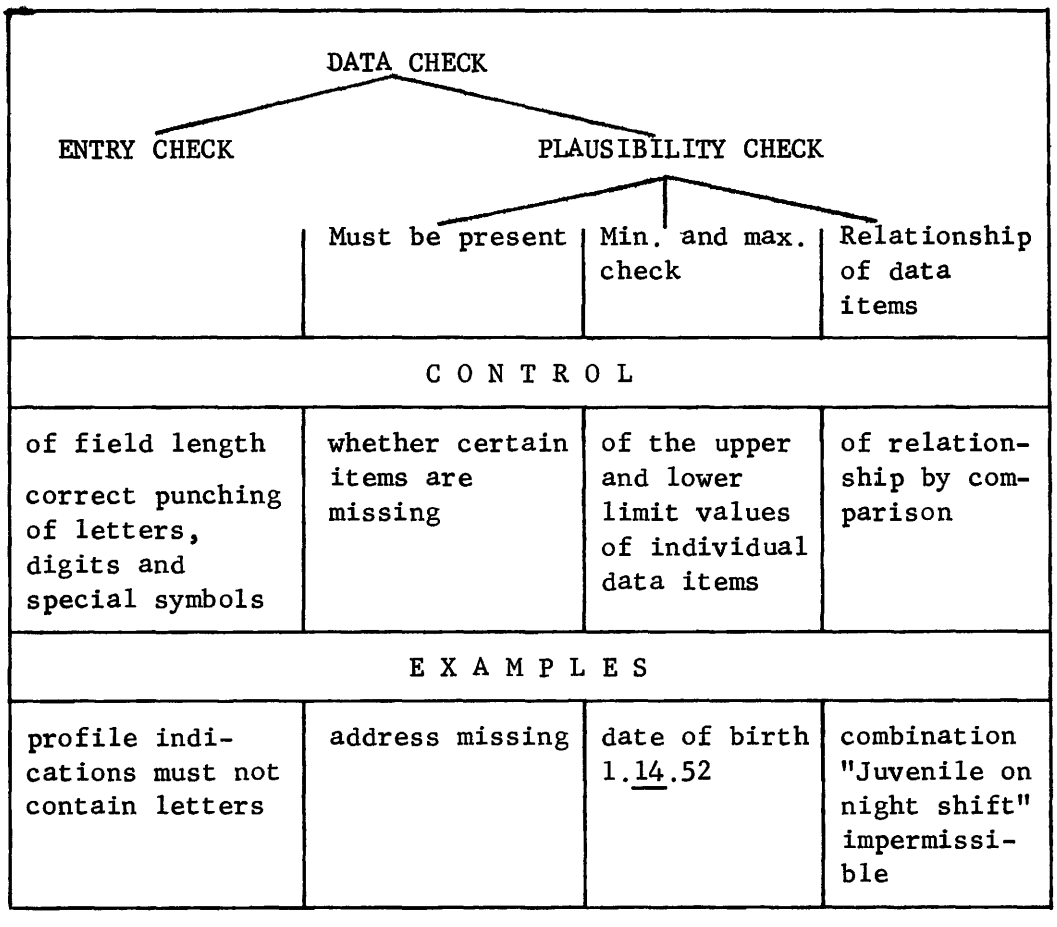

Fig. 16 : Data checking procedure

The first check or entry check ascertains :

1) whether the data field had the specified length,
2) whether only letters, figures or special symbols or a combination of the three have been entered.

The subsequent plausibility check in which the logical correctness of the data is ascertained is subdivided into three steps according to Figure 16. In the first the presence of essential data ia ascertained, such as the workplace number and card type index. The name, address,etc. are also important under the personnel data and, for workplace data, complete entry of the characteristic grades with the corresponding priority indexes.
In the second stage the data fed in is compared with the specified minimum and maximum values. In this way it is determined whether e.g. the maximum possible grade number has been exceeded for characteristics and priorities, or whether a meaningless month was shown under the date of birth. In the final stage all the data for a workplace or person is compared as far as possible. It is then possible to determine whether the age allows the indicated level of training, whether juveniles or women have been earmarked against the regulations for heavy physical work, for lifting heavy loads or for night shift. The errors ascertained in these checks are printed out on a list by the high-speed printer which shows the relevant workplace or personal number, card type index, characteristic number and one of 12 specified types of error. In addition the relevant workplace or personal number is recorded on a magnetic tape so that error checks and rapid retrieval of the error are possible for subsequent improvement. Not until all the data is accurate is it finally stored in the relevant index.

5.2.2.2 Data storage

After checking the read-in data for the absence of errors it is stored in a data bank. There is not yet a standard solution for the design of a data bank of this kind; whenever a problem arises an economic and technically satisfactory solution must be found.

Initially a suitable data store had to be selected.
In order to estimate the amount of data to be stored in a particular application a large enterprise with 10,000 employees and 2,000 different workplaces was chosen. The information on one person comprises a total of about 270 alphanumeric symbols while some 240 symbols are required to describe a workplace (see Figure 14). The following storage capacity must therefore be expected :

10,000 employees x 270 symbols per employee
\+ 2,000 workplaces x 240 symbols per workplace
= 3,180,000 symbols.

To address the individual items an additional storage capacity of about 20 % must be provided. This gives a total requirement of about 3,180,000 x 1.20 = 3,816,000 symbols.

For unpacked storage - a non-compressed type of storage which allows easy processing - each symbol is represented by a byte, the smallest addressable unit in EDP. This gives a storage capacity of about 3.8 kB (Kilobytes). This is a minimum value which is largely exceeded in most personnel data files described in literature (see BOJE 3, p. 14-16; DIEDENHOFEN 6, p. 56-62).

Starting from the above application example a data store had to be found which met the requirements for

1) adequate storage capacity,
2) short access time and
3) high reading speed during recall of data

as uniformly as possible. For requirements of this kind only magnetic disc stores with a capacity of up to 100 million bytes per disc and relatively high access and reading speed were considered.

The workplace or personal number were used as the data classifying concepts. As the workplace number and - when the federal individual index is used - the personal number generally consist of classifying numbers, an index-sequential organization was chosen to design the data stores. This form of organization is characterized by the fact that the classification concept with the address of the classified item is stored in a separate part of the disc. This allows direct access to each individual item.

5.2.2.3 Data organization

After determining the data support and data store it is possible to show the overall structure and organization of a workplace and personnel data bank on the basis of the data flow chart given in Figure 17 :

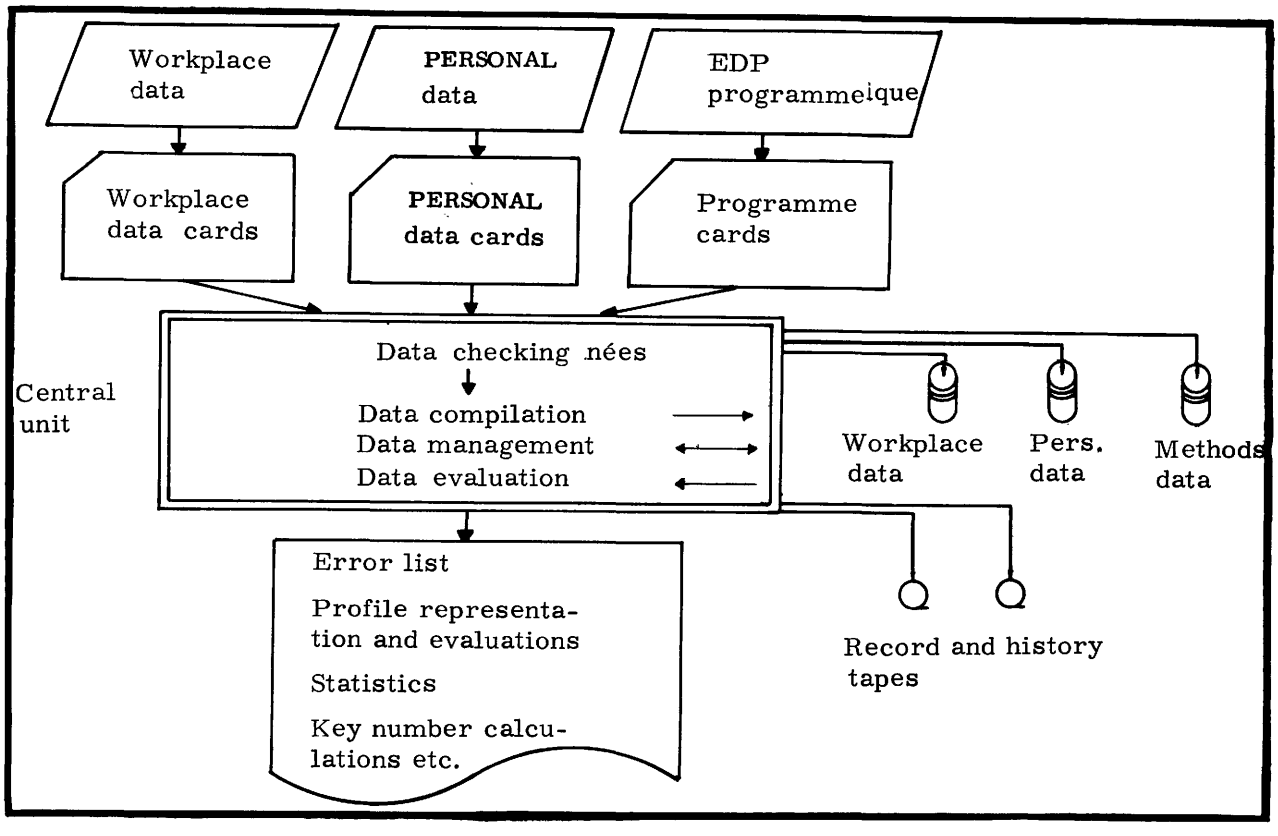

Fig. 17 : Data flow chart

The workplace and personnel data is recorded in the enterprise with the aid of the survey forms mentioned in Chapter 4.2 and converted into machine-

legible form with card punchers and verifiers. The data is then fed into the central unit of the EDP system by a card reader and stored in the workplace and personnel data files. The programmes are also read in by punched cards. These programmes are stored in the methods data bank and can be used at any time.

The computer programmes already developed in this project are listed and described briefly below.

- API 100 : The programme reads in workplace and personnel data on punched cards, carries out entry and plausibility checks (see Chapter 5.2.2.1), prints out any errors and stores the data in the sequentially structured "INPUT 1" or "INPUT 2" files on magnetic discs.
  A simplified flow chart for this programme is given in the Appendix 8.3.1, page 54.

- API 200 : The programme converts the "INPUT 1" and "INPUT 2" data into the index-sequentically structured data files "AP-PRO" (workplace data) and "MA-PRO" (personnel data).

- API 300 : The programme reads off workplace and personnel data from the magnetic disc and prints it out in a clear list form on the high-speed printer (see Annex 8.4, page 57 - 60).

- API 350 : The programme stores a "Black Matrix" structured in the core store on magnetic disc. This "Matrix" provides the constant screen onto which data from the graphic profile comparison is printed, comparable with the value entries on a form.

- API 400 : This programme makes a profile comparison between aptitude characteristics of a staff member and requirement characteristics of his current workplace and prints out the graphic profile presentation and the results of the numerical evaluation (see Figure 18.1, page 123 and Annex 8.3.2, Page 55).

- API 600 : This programme is used to alter and update the workplace file "AP-PRO" and the personnel file "MA-PRO" (see Annex 8.3.3, page 56).

- API 610 : This programme clears data items from the "AP-PRO" and "MA-PRO" files.

- API 620 : This programme adds data items to the "AP-PRO" and "MA-PRO" files.

- API 700 : This programme determines individuals whose personnel data in the occupational experience characteristic group contains a workplace number which coincides with a number indicated on a previous card. The personal numbers of the individuals concerned are printed out.

- API 720 : This programme calculates for all staff the total deviation indexes with reference to a workplace number indicated by a previous card and stores the personal numbers with the corresponding total deviation indexes which do not exceed the given tolerance on an EDP internal table.

- API 730 : This programme effects profile comparisons between the requirements of the workplace indicated on a previous card and the aptitudes of the staff selected in the EDP-internal table. The number of comparisons can be limited by a previous card. The results of the comparisons are indicated by the high-speed printer.

- API 740 : This programme calculates for all workplaces the total deviation index with reference to a staff member whose personal number is indicated by a previous card and stores the workplace number with the corresponding total deviation indexes which do not exceed a given tolerance on an EDP-internal table.

- API 750 : This programme effects profile comparisons between the aptitudes of a staff member indicated on a previous card and the requirements of the workplaces selected from the EDP internal table. The number of comparisons can be limited by a previous card. The results of the comparison are indicated by the high-speed printer.

- API 770 : This programme compiles for the workplaces of one or more selected enterprise areas the requirement structures of certain characteristics; the nature and number of areas and characteristics are indicated by previous cards. The result is printed out in the form of a requirement topography and two lists showing the workplaces with the highest requirements (see Chapter 5.3.2 : Example 3).

Apart from these existing programmes which are concerned essentially with the evaluation of various profile comparisons, further programmes necessary to the functional efficiency of an API have to be developed before practical use begins.

These include programmes to file the stored data so that it is not lost if the store content of the disc store is destroyed or in the event of technical failure of the EDP system. A further programme would be necessary to protect the personnel data against unauthorized access. Either fixed or "self-consuming" code words could be used for this purpose or else data print-out could be made conditional on a specific question-answer sequence or the use of an individual card with invisible magnetic characters. Programmes would also have to be compiled to sort out obsolete or little-used data from the workplace and personnel indexes and transfer them to history tapes. Finally the use of a visual screen unit would be desirable

to allow dialogue in data storage, administration and evaluation.

Information will be found in the next chapter on the possible application of the existing evaluation programmes described above and their inter-relationship in solving current management problems.

5.3 Practical application

5.3.1 Possible applications

Starting from the aims of evaluation described at the beginning of Chapter 5, the already developed or planned or proposed programmes have the following practical application possibilities : the first possibility is the analysis of present personnel utilization in which the requirements of a workplace can be compared with the corresponding aptitudes of the present occupants. If the workplace and personnel data is not yet available in the workplace or personnel files, it is stored index-sequentially in these files with the aid of programmes API 100 and 200. If the data files already exist the programmes API 350 and 400 can be loaded directly together with the personal number of the staff member indicated on a previous card.

With the workplace number shown in the personal data for the present activity, the programme is able to trace the original workplace of the staff member concerned in the workplace file. The indication found in this way is presented graphically together with the aptitude values in a profile form and evaluated according to the observations made in Chapter 5.1. If a considerable latent aptitude potential is found on the basis of "knowledge not required at the workplace" and "overlap", the use of this staff member at a more demanding workplace should be aimed at. If

the evaluation of the comparison data shows considerable "underlapping" a check should be made to ascertain to what extent it is still relevant to the activity of a fully trained staff member; a number of characteristics which are given high priority at the beginning of an activity may be compensated by long experience at the workplace. Any genuine underlapping found after this check should be followed by further training measures, staff transfers or ergonomic workplace design. The latter possibility is discussed separately later.

A second possible application is for the short-term filling of a vacant workplace (see example 1 in Chapter 5.3.2). The sequence is then as follows :

With the aid of programme API 700 and the workplace number indicated on a previous card, the programme "searches" through the entire personnel data file in order to ascertain which staff member was previously active at the workplace and prints out the corresponding personal numbers of the staff members concerned. If none of the previous workplace occupants is able or willing to return to this workplace a search may be made for closely related workplaces. If no suitable staff member is still found a profile comparison is carried out into two stages. First programme API 720 is used to determine those staff members whose total deviation index does not exceed a lower limit indicated by the previous card. The personal numbers of these staff members and the corresponding indexes are stored in a "table" on a magnetic disc. In the second stage this table is sorted by programme API 730 initially to determine minimum deviation indexes. The high-speed printer then prints out the data of suitable staff members in profile form with the corresponding comparative data evaluations.

This procedure can also be inverted to select a suitable workplace for a particular individual. The necessary profile comparison is analoguous to the procedure described above, i.e. with the aid of programme API 740 the EDP system internally lists the workplaces and corresponding deviation indexes with reference to the given aptitude potential; the list is then sorted with programme API 750 and the workplaces best suited to the staff concerned are printed out in a profile presentation.

In addition to these already feasible applications of the profile comparisons there is another one for which a corresponding computer programme would still have to be developed, namely the detailed design of production plants in which - in line with the requirements of the future workplaces - draft personnel manning plans could be compiled. The programme prepared for this purpose should aim at optimizing the utilization of existing aptitude potential by maximizing the sum of the suitability levels or minimizing the sum of the deviation indexes. The calculation process necessary for this purpose and details of the programme will be found in DOMSCH u. GABELIN (8, p. 71, 72), SCHÖNFELD (59, p. 757), KUHN (38) and GOTTSCHLING (19). As a result of the programme the personnel allocation is printed out in a profile presentation with the corresponding comparative data evaluation. This result print-out can then form the basis of the personnel manning plan in which personal wishes and peripheral social conditions which cannot be covered in the aptitude profile should also be taken into account.

With the aid of a personnel manning model of this kind HILDEBRANDT (30, p. VIII-7 to 10) draws attention to possibilities of improving the utilization of staff with unchanged working conditions. He ascertained in addition to the optimum overall value a pessimistic value and the currently feasible value so that for each individual transfer the percentage improvement of the entire system can be determined.

In addition to these applications of the profile comparison it is possible to compile statistics and calculate enterprise-specific indexes for individual data groups. The programmes developed for this purpose must be adapted to the individual instance (an example of a simple statistical evaluation will be found in Chapter 5.3.2). With programmes of this kind material can be provided for decisions on many problems in the area of personnel requirement, personnel utilization and personnel development planning as well as for ergonomic workplace design which will be considered in more detail here :

One extremely interesting aspect of application of the API is to ascertain particularly high requirements at the workplace, e.g. by muscular strain or environmental influences such as heat, noise, dust, etc. (see example 3 in Chapter 5.3.2). With the aid of programme API 770 the simultaneous occurrence of heat and strenuous work, requirements on concentration or perceptive faculties with a simultaneously high noise level, etc. can be checked.

One further central feature of ergonomic work design in conjunction with the evaluation of workplace and personnel data is the reduction of accident frequency at certain workplaces. This aim can be achieved if, at fixed intervals or in current situations results of the accident statistics are compared with the requirement analyses of the workplaces so that correlations between accident frequencies and typical requirement structures or requirement peaks become apparent. In this way it will be possible to intensify the human design of workplaces by carefully planned ergonomic measures.

Great importance also attaches to the recognition and design of workplaces for the handicapped. Here too the results of the evaluation of workplace and personnel data may help to detect such workplaces from the totality of existing workplaces and enable them to be ergonomically designed to make

better allowance for the special requirements of the handicapped. A start has been made in this direction in several enterprises already. It should be easier to systematize and further develop the data on the employment of handicapped persons by evaluating workplace and personnel data in the context of an API system.

5.3.2 Examples of evaluation of recorded data

To clarify the possible applications of the API described above, three examples are quoted showing how relevant information can be obtained with the instruments developed.

Example 1

Problem : The post of "controller-plate mill finishing stand" has to be filled. No suitable candidate can be found on the external labour market and in the rolling mill itself. For this reason it is decided in the enterprise which has a workplace and personnel data system of the type described above to ascertain by profile comparison which staff in other areas of the enterprise have an aptitude profile presenting the requirement profile of the workplace to be filled. The decision on filling the workplace is then taken by the method described in Chapter 2.3.

The procedure to solve a problem of this kind is discussed below and the results of the profile comparison are then explained.

After programme API 700 has failed to find a staff member who had previously filled a finishing stand controller's workplace, the data on which the profile comparison is to be based is defined. For this purpose

the number of the workplace to be filled, e.g. "controller-plate mill finishing stand" - and the number of the enterprise/working area in which suitable staff are to be located is read in to the computer with profile evaluation programmes API 720 and 730. An upper limit value for the total deviation indexes is not defined; the number of profile comparisons to be printed out is, however, limited to three for greater simplicity by using a previous card. The data required for the profile comparison stored in this practical application in the workplace or personnel data files was taken for this example on the workplace side from the data recorded in the industrial studies, and simulated on the personnel side on the basis of data actually recorded. No personnel data ascertained in the enterprise itself - in particular of a medical and psychological nature - was used in order to ensure individual privacy in the context of this published report. The data on the workplace to be filled and the personnel data for the three staff members will be found in the list printed out by the computer in Annexes 8.4.1 - 8.4.4, pages 57 - 60. Lists of this kind can be obtained for each workplace covered in the API or each staff member using programme API 300[1)].

The three profile presentations with additional evaluations printed out by the high-speed printer as a result of the profile comparison are shown in Figures 18.1 to 18.3. However, before considering the evaluation of the profile presentation, the method of presenting a profile print-out by the high-speed printer will be clarified by the examples shown in Figure 18.1.

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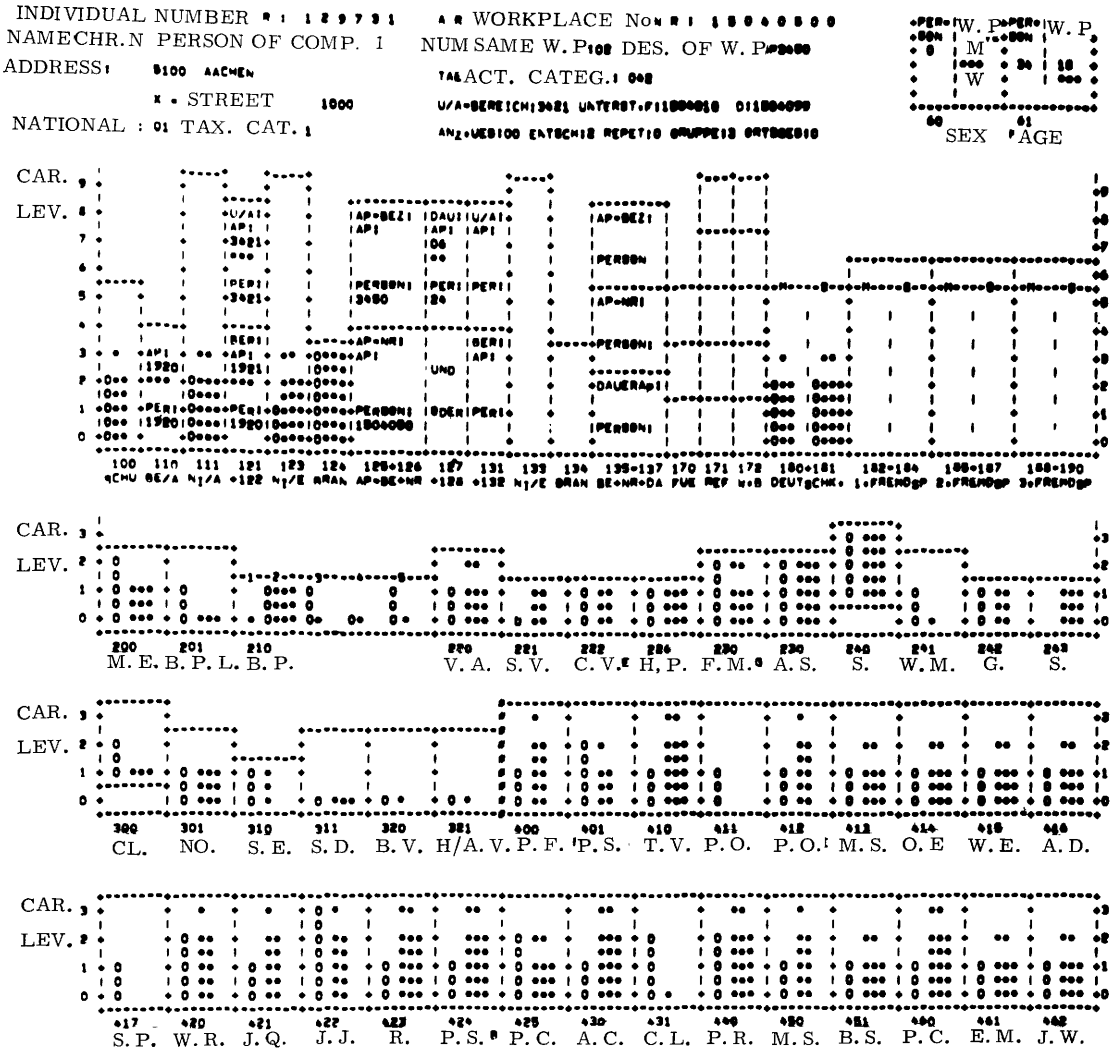
1) The data list shown in the appendix and the programme print-outs in the text below are structured according to the survey guidelines for the industrial studies; the number of characteristics and the characteristic designation therefore differ in some respects from the attached catalogue of characteristics. Because of the additional programming effort, conversion to the catalogue which appears in the annex was not effected. In the event of practical industrial introduction, an adaptation to special operational characteristics and a review of the programme will probably be necessary.

The comparison data for the workplace and personnel is listed together in sectors arranged next to each other in the sequence of the characteristic numbers. In so far as requirements or aptitudes can be graded for these characteristics, the comparison data was presented in the form of columns. The height of these columns - consisting of circles for aptitudes and asterisks for requirements - indicates the level of the characteristic. The urgency of compliance with the workplace requirements - expressed by the priority figures - is represented by the number of adjacent asterisk columns. For example three adjacent asterisk columns (priority index 3) indicate that the characteristic must be met in the prescribed level. This is the case for example for characteristic 200 in Figure 18.1. The presentation in the section for characteristic 200 indicates that the aptitude of the individual in respect of this characteristic is one grade higher than the workplace requirement, i.e. medical examination shows that the individual concerned is also able to perform work involving high muscular effort. In this case therefore - on the aptitude side - there is some overlapping while, e.g. in the case of characteristics 222, 226 and 230 there is congruence and in characteristics 221, 400 and 410 underlapping.

With the allocation of the workplace requirements to particular grades, for some characteristics - in particular psychological characteristics - an additional evaluation described in Chapter 3.3.4.2 is simultaneously effected. It is clear for example in the case of characteristic 220 (visual acuity) that visual acuity of grade 1 is absolutely essential (priority 3) but that acuity of grade 2 should preferably be ensured (priority 2). The dotted line which limits the profile at the top indicates the maximum value of the grade scale which is reached, e.g. in characteristic 240 with grade 3 both on the requirement and aptitude sides.



KNOW = NOT REQUIRED WORKING-PL

FOLLOW. ACTIV		PROF	LEVEL	BRANCH	DES. W. P	W. P. No	DURATION
		PROF	LEVEL	BRANCH	DES. W. P	W. P. No	DURATION
		PROF	LEVEL	BRANCH	DES. W. P	W. P. No	DURATION
		PROF	LEVEL	BRANCH	DES. W. P	W. P. No	DURATION

2 FOLLOW. DRIV. LIC
3 FOLLOW. REFA-LIC
4 FOLLOW EVID. OF CAP
5 FOLLOW CAR. OF FORM.
6 FOLLOW. FOR. LANG.

INSUFFICIENCIES

PRIOR. LEV. LEV. NOT FIL. CAR. No
PRIOR. LEV. LEV. NOT FIL. CAR. No
PRIOR. LEV. LEV. NOT FIL. CAR. No
PRIOR. LEV. LEV. NOT FIL. CAR. No
PRIOR. LEV. LEV. NOT FIL. CAR. No
LEV. NOT FIL. CAR. No

SUPERABUNDANCES

PRIOR. LEV SURABON. LEV. AT CAR. No
PRIOR. LEV SURABON LEV. AT CAR. No
PRIOR. LEV SURABON LEV. AT CAR. No
PRIOR. LEV. SURABON. LEV. AT CAR. No
PRIOR. LEV SURABON LEV. AT CAR. No

DEV. CAR.

KNOWL.	INSUFF.	SURABON.	
PHYS. CAR.	INSUFF.	SURABON.	
ENV. INFL.	INSUFF.	SURABON.	
PSY. CAR.	INSUFF.	SURABON.	
	INSUFF.	SURABON.	

Fig. 18.1 : EDP print-out of profile comparison 1

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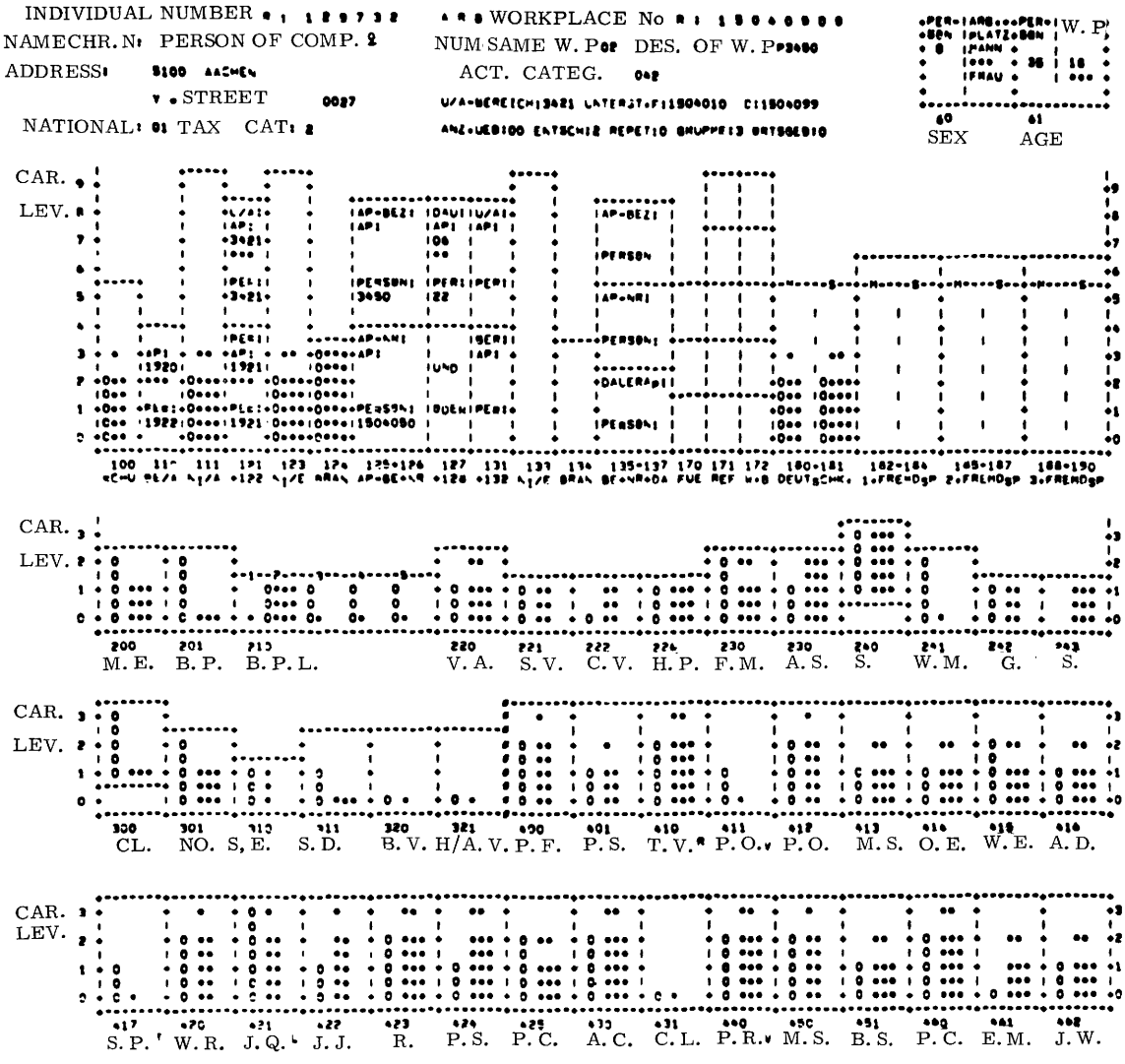

KNOW. NOT REQUIRED WORKING-PL

FOLLOW ACTIV	PROF	LEVEL	BRANCH	DES. W. P.	W. P. No	DURATION
	PROF	LEVEL	BRANCH	DES. W. P	W. P. No	DURATION
	PROF	LEVEL	BRANCH	DES. W. P	W. P. No	DURATION
	PROF	LEVEL	BRANCH	DES. W. P	W. P. No	DURATION

FOLLOW DRIV. LIC
FOLLOW REFA-LIC
FOLLOW EVID. OF CAP
FOLLOW. CAR. OF FORM
FOLLOW FOR. LANG

INSUFFICIENCIES

PRIOR. LEV.
PRIOR. LEV.
PRIOR. LEV.
PRIOR. LEV.
PRIOR. LEV.
PRIOR. LEV.

SUPERABUNDANCES

PRIOR. LEV. SURABON. LEV. AT CAR. No
PRIOR. LEV. SURABON. LEV. AT CAR. No
PRIOR. LEV. SURABON. LEV. AT CAR. No
PRIOR. LEV. SURABON. LEV. AT CAR. No
PRIOR. LEV. SURABON. LEV. AT CAR. No

DEV. CAR.

KNOWL.	INSUFF.	SURABON.
PHYS. CAR.	INSUFF.	SURABON.
ENV. INFL.	INSUFF.	SURABON
PSY. CAR.	INSUFF.	SURABON
	INSUFF.	SURABON

Fig. 18.2 : EDP print-out of profile comparison 2

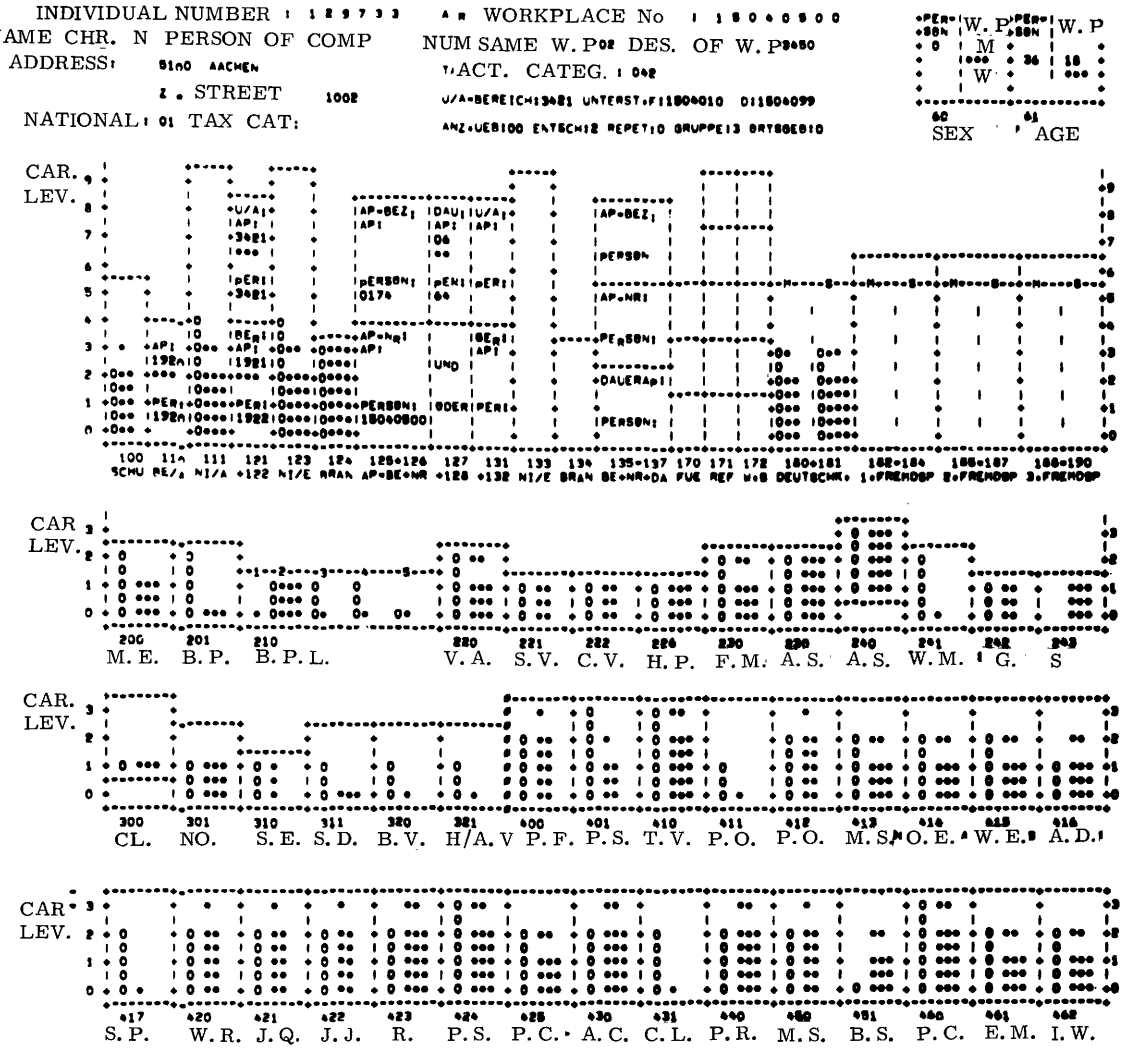

Fig. 18.3 : EDP print-out of profile comparison 3

The individual asterisks which appear against characteristics 311, 320 and 321 show that while the characteristic was tested it is not relevant to the workplace.

The numerical evaluation of the profile comparison printed out under the graphic profile presentation in each case was already explained in Chapters 5.1.2 and 5.1.3. The compressed result of this evaluation represents the total deviation index, the composition of which is indicated by arrows at the bottom of Figure 18.1.

The total deviation indexes calculated for the three profile comparison examples are derived from the three profile print-outs (Figures 18.1 to 18.3). The values are as follows :

for comparison subject 1 : 2330000063
comparison subject 2 : 1350000148
comparison subject 3 : 480000283.

By definition the individual with the lowest index, i.e. comparison subject 3 would therefore be most suitable to fill this workplace.

However, the total deviation index - as already repeatedly mentioned - cannot be used as the single final decision criterion to fill a workplace for the following reasons :

- The weighting of the individual characteristics in the profile comparison by indicating a priority figure is sufficient for the preselection of staff from a large basic total but too coarse for a differentiated assessment of their suitability.

- Professional experience from earlier activities is only partly taken into account in the profile comparison and hence in the total deviation index.

- Personal inclinations and wishes are not considered.

- Questions of labour law and in particular of industrial statutes must be clarified separately.

While the second to last item is generally the subject of a personal interview, by differentiated analysis of the profile print-outs it is possible to ascertain information on the first two points which allows interpretation of the calculated total deviation index. Comparison of the deviation indexes for the individual data groups at the end of the print-out shows for example that comparison subject 3 has a high overlapping index of 93 in the knowledge area, by comparison with the two other subjects. This is largely due to the high overlapping of the existing training and experience level because the individual concerned has passed a specialized skilled work examination (see indication in the sector for characteristics 110, 111, 121 and 123 and the corresponding codes in the catalogue of characteristics). The relatively high level does not, however, relate as in the case of comparison subject 2 to the required occupation class 1921 (hot roll operator) but to occupational category 1922 (cold roll operator). This underlapping may be more significant because of special operating conditions than the high number of overlaps which tend to suggest that the individual concerned should be employed at a different workplace with higher requirements than this one.

The initially favourable total deviation index of comparison subject 3 now appears in a different light so that comparison subject 2 with his balanced ratio of overlap, underlap and congruence of the profile in the important requirement characteristics for this workplace - training and experience level (110-124), understanding of technical processes (410), powers of reaction (440) and ability to concentrate (460) - can be considered more suitable although the total deviation index is higher.

On the other hand underlap is most of the characteristics referred to, reflected in a comparatively high total deviation index, suggests that the employment of comparison subject 1 would be much less desirable.

The information obtained from the profile comparisons described above on the suitability of staff for a specific workplace can be taken as the basis for the further steps towards a decision on the final employment described in Chapter 2.3.

Example 2 :

In this example a comparison of comparative data from the group of psychological characteristics is evaluated statistically. Comparisons of this kind can help to detect high workplace requirements in individual operational areas in order to arrive at measures to reduce requirement peaks of this kind.

In the selected example the relative frequencies of the requirement grades which occur for three characteristics for different operational areas were defined and the results shown in Figure 19.

For evaluation purposes the characteristics of practical skills (characteristic No. 401), quality of work done (characteristic No. 421) and reaction powers (characteristic No. 440) were selected in the context of this report. The industrial areas involved were the blast furnaces, steelworks, rolling mill and maintenance sectors covered by the industrial studies (see Chapter 4.2). These sectors were taken from different enterprises but we assume that the requirement structures of comparable enterprise/working areas in different firms do not differ more substantially than the same structures in a single enterprise.

The following detailed information was obtained from Figure 19. The requirement structure of the practical skills characteristic is essentially the same for the three areas (blast furnace, steelworks and rolling mill), the commonest requirement level being grade 1. In the maintenance area the distribution is concentrated on grade 2 to which almost 70 % of the workplaces belong.

A similar picture is obtained for the quality of work performed characteristic where the frequency peaks for the three areas referred to above fluctuate between grades 1 and 2, but the maintenance area can be attributed solely to the high requirement grades 2 and 3.

In contrast the frequency distribution for the reaction power characteristic shows that the requirements for this characteristic are very similar in all four areas. The frequency of grade 1 is between 60 and 70 % in all areas and the distribution of the upper grades practically identical.

Comparison of the frequency distribution shows that the requirements on workplaces in the maintenance sector or on the psychological characteristics "practical skill" and "quality of work performance" are generally higher than in the other areas although no significant differences occur in the case of the "reaction power".

This information obtained from these diagrams on the requirement structures cannot be defined as new as it essentially represents generally known conditions; however, it was shown that these fairly intuitive characteristics or evidence based on experience could be objectified by a more precise requirements screen so that both differences and similarities in the requirements structure would be highlighted.

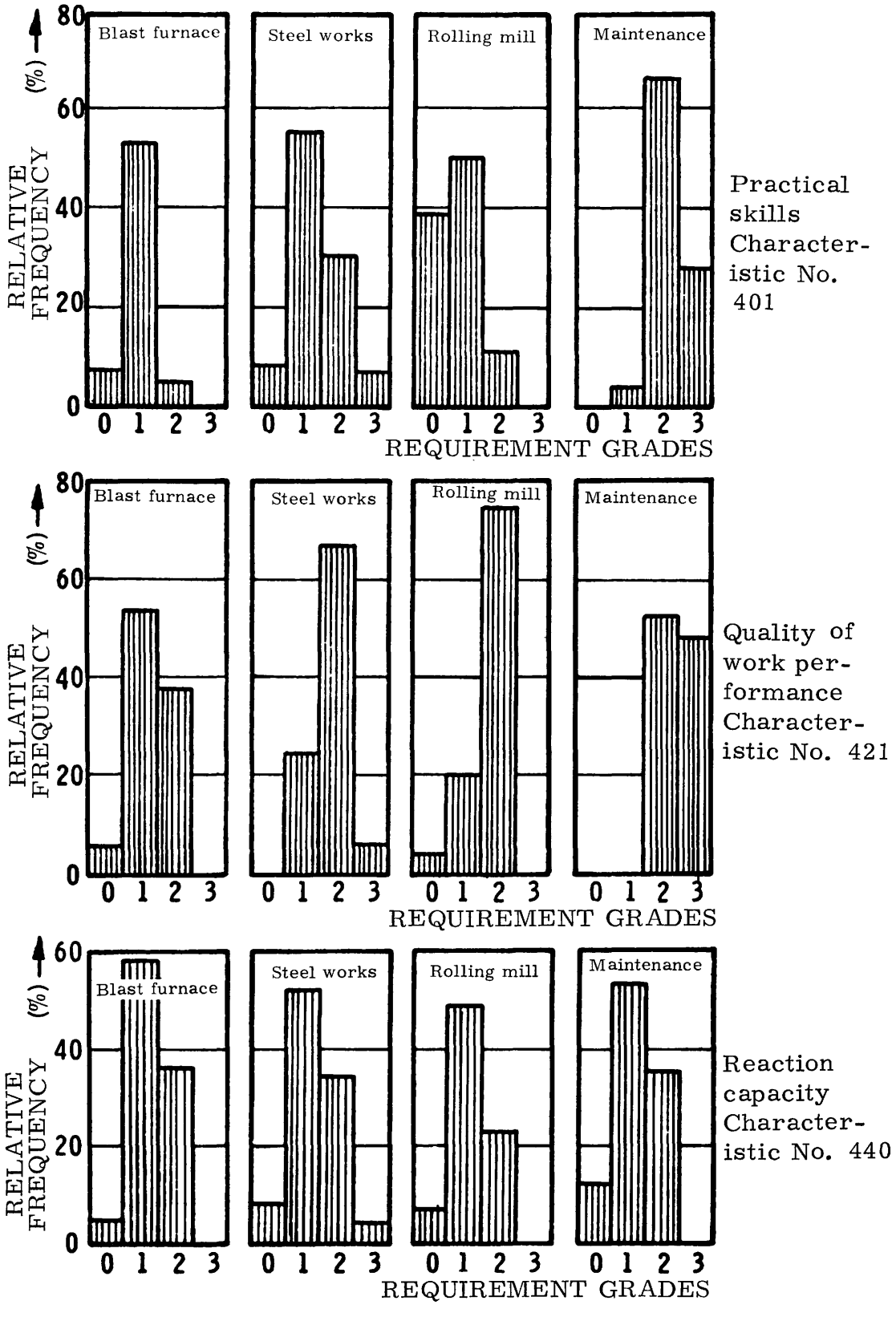

Fig. 19 : Relative frequency of requirement grades for the characteristics practical skill, quality of work performance and reaction power in the different study areas.

Example 3

Problem : the requirement structures in respect of specific characteristics are to be determined for all the workplaces in a works area. The level of the individual requirements for each workplace must be clear in order to deduce measures for ergonomic work design.

For the example, the enterprise areas "oxygen converter steel plant" with the sub-areas

- Converter operation (No. 3311)
- Block casting (No. 3312)
- Yard work (No. 3314)
- Continuous casting finishing (No. 3315)

and the requirement characteristics

- Muscular effort (No. 200)
- Brief load peaks (No. 201)
- Climate (No. 300)
- Noise (No. 301)

wer chosen.

Programme API 770 is used to solve a problem of this kind (see Chapter 5.2.2.3). If the existence of a complete workplace data file is assumed, only two previous cards need to be added to load the programme, showing in the first case the numbers of the sub-areas referred to above and in the second the numbers of the characteristics listed above. The structural presentation shown in Figure 20 is then printed out on the high-speed printer.

Part 1 of the illustration shows the requirement topography of the four characteristics for all workplaces in the individual sub-areas. The method of presentation is similar to that of the profile comparison (see Figure 18.1 - 4), i.e. the level of the asterisk columns indicates the level of requirements and the number of adjacent columns the priority. The

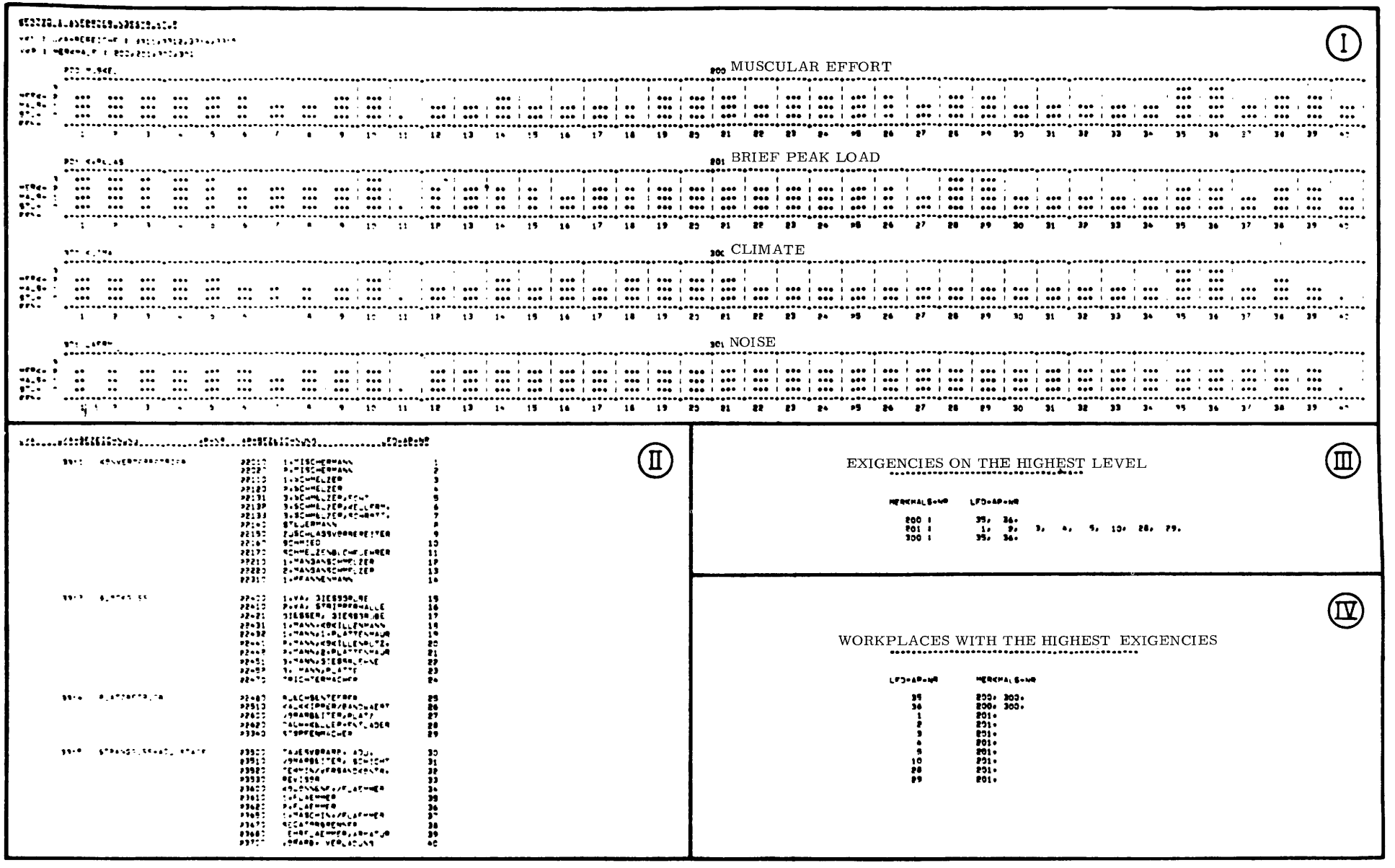

Fig. 20 : Requirement structures of a work area in respect of selected characteristics

consecutive workplace numbers 1 to 40 which appear under the individual sectors can be de-coded by means of the table which appears in Part II. The graphic presentation in Part I gave a good general picture of the requirement structures concerned but is less favourable for evaluation in which the requirements of several workplaces are to be compared, especially when a large number of characteristics are involved. For this reason the requirement typography is followed by two additional evaluations, the first of which (Part III) lists for all characteristics the workplaces at which the requirement appears in the highest grade. The table in Part IV indicates for each workplace the characteristics occurring in the highest grade in an order of priority in which the workplaces with the greatest number of requirements in the highest grade are listed first.

Evaluation of the requirement structures of our sample working area gave the following results :

1. The list of requirements in the highest grade (III) shows that the characteristics 200 (muscular effort) and 300 (climate) only occur in the highest requirement grade at two workplaces, while characteristic 201 (brief peak load) appears in the highest grade at a total of eight workplaces and it is striking that six of these are in the converter operation sub-sector. For characteristic 301 (noise) a maximum requirement did not occur at any of the workplaces listed here; the graphic presentation (I) shows, however, that the noise level is constantly in grade 2 for practically the entire study area.

2. The list of workplaces with highest requirements (IV) indicates numbers 35 and 36 as the workplaces with the highest loading - in respect of the characteristics listed here - i.e. maximum requirements occur both for characteristic 200 (muscular effort) and 300 (climate) at both workplaces.

The results of these evaluations can be taken at the point of departure for ergonomic design measures which might relate in this particular case to the reduction of the brief load peak in the converter sector and to special health protection measures, such as rationally planned industrial medical care for workplaces 35 and 36.

The two evaluations listed in this example which are intentionally brief and simple to ensure easier understanding, represent only two possibilities of evaluating requirement structures. According to the particular application other evaluations could be effected, e.g. a listing of workplaces with the lowest requirements to select workplaces suitable for handicapped persons. Workplace 11 might be a suitable case in which the requirements for all four characteristics were at the lowest level.

The actual advantage of the procedure described above to compile requirement structures lies not in the possibility of finding a basis for work design measures as in the fact that these problems can be analyzed extremely quickly with a programme integrated in the API. The time required to compile the requirement structures described in this example is about ten minutes, the greater part of which is taken up by punching the lead cards. If a screen display terminal is used this time would be reduced to a fraction of a minute as the necessary control data could be fed in directly on a keyboard.

The examples shown here merely illustrate three out of many possible applications which might arise in industrial practice. The way in which

the instruments described in this report can be used and tested for further problems and tasks of industrial personnel management will be dealt with in further studies which could be conducted in conjunction with the planned follow-up project. Relevant information has already been given at various points in this report.

6. SUMMARY AND PROSPECTS

This report had tried to show how necessary it is for enterprises in the iron and steel industry to expand and develop their information on workplace characteristics and requirements and on the aptitude of skilled workers employed in these enterprises. This need is particularly apparent from the angle of further technical and organizational development as a result of which workplaces are developed with widely varying activity contents and requirement structures which no longer coincide with the traditional occupational and activity patterns and can be ascertained with sufficient accuracy only by detailed workplace analyses.

Only when this information - including the corresponding personnel data - is made available to the appropriate departments of an enterprise with the aid of corresponding instruments will it be possible to progress in personnel management from the stage of primarily intuitive decision-making to a more objective decision structure.

Workplace analyses are only used in three areas today : for work design, wage calculation (see EULER; STEVENS 11) and to solve specific questions of industrial science; it is extremely rare for them to be used to facilitate the many tasks of personnel planning. After surveying the possible applications of workplace and personnel analyses in the context of personnel-related enterprise functions, certain requirements were deduced which should be placed on the structure and form of the results of the method to be developed.

A proposal as to how these requirements could be met by a suitable form of workplace and personnel analysis is the central feature of this project report. Of the theoretically possible solutions for a comparison

of the requirements and aptitudes which were briefly outlined, the profile method was considered the most suitable although it presents a number of methodological problems.

Because of the complexity of the data to be stored and the large number of evaluations and comparisons in a wide range of characteristic combinations - which must also be made available generally extremely quickly - it is desirable to store and process the results of the aptitude and requirement analyses in an EDP system. Electronic processing can alone enable the wide applications of the analysis method to be utilized but the data must be acquired in a special form. The problems arising from the EDP-oriented data structure were largely solved.

A distinction was made between three types of characteristics required for workplace and personnel analyses and their constituent parts were explained : characteristics which identify, describe and characterize requirements or aptitudes.
Identifying characteristics include the workplace and personnel number required as the address for all the other characteristics. The descriptive characteristics largely take over on the workplace side the function of the job description used previously; on the personnel side the descriptive data on the individual is acquired in clear text.

The requirement and aptitude characteristics as such were divided into five main characteristic groups in all in order to allow partial data to be acquired where necessary :

A) General characteristics,
B) Knowledge characteristics,
C) Physical characteristics,
D) Environmental influences
E) Psychological characteristics.

The structuring and grade of the characteristics in these main groups was chosen in such a way that direct comparability of requirements and aptitudes is largely ensured.

In a total of four industrial studies the practical applicability of the analysis method with the survey instruments developed for this purpose was tested. The experience gained led to a review and tightening up of the catalogue of characteristics which could be submitted as a proposal in its present form to enterprises in the iron and steel industries.

The concept of a data system was developed for processing workplace and personnel data. The basis of the system is a workplace and data bank which can provide a wide range of data for practically all areas of industrial personnel management. After a short explanation of the way in which a workplace and personnel data system can be integrated into a management information system, the structure of the information system and its technical realization are outlined. The central feature consists of the programmes in a programme library for comparing data in the form of a graphic profile comparison and the programmes for numerical comparison evaluation.

The main evaluation possibilities for personnel management - filling jobs, selecting suitable workplaces or persons, personnel utilization models, statistics - and the possibilities of obtaining information for ergonomic work design in the recorded data were then explained.

The data fed into the workplace and personnel information system does not, however, represent a static value; it is affected by a number of influencing parameters which result in the course of time in changes in the workplace and personnel data. The task of effective personnel planning must be - because of the time required for measures of personnel recruitment, development and release - to ascertain in the longest possible term the effects of the influences on the qualitative and

quantitative structure of workplace and personnel data.

Figure 21 shows the basis outline of a personnel planning model of this kind. It will be seen that the planning model must have as its basis the analysis data contained in this report. Continuing technical and organizational changes on the workplace side and the improvement of educational prospects as well as the greater need for self-development and self-realization on the personnel side are among these important influences which must be considered in a forecast of the future workplace and personnel structures. These long-term changes may endanger

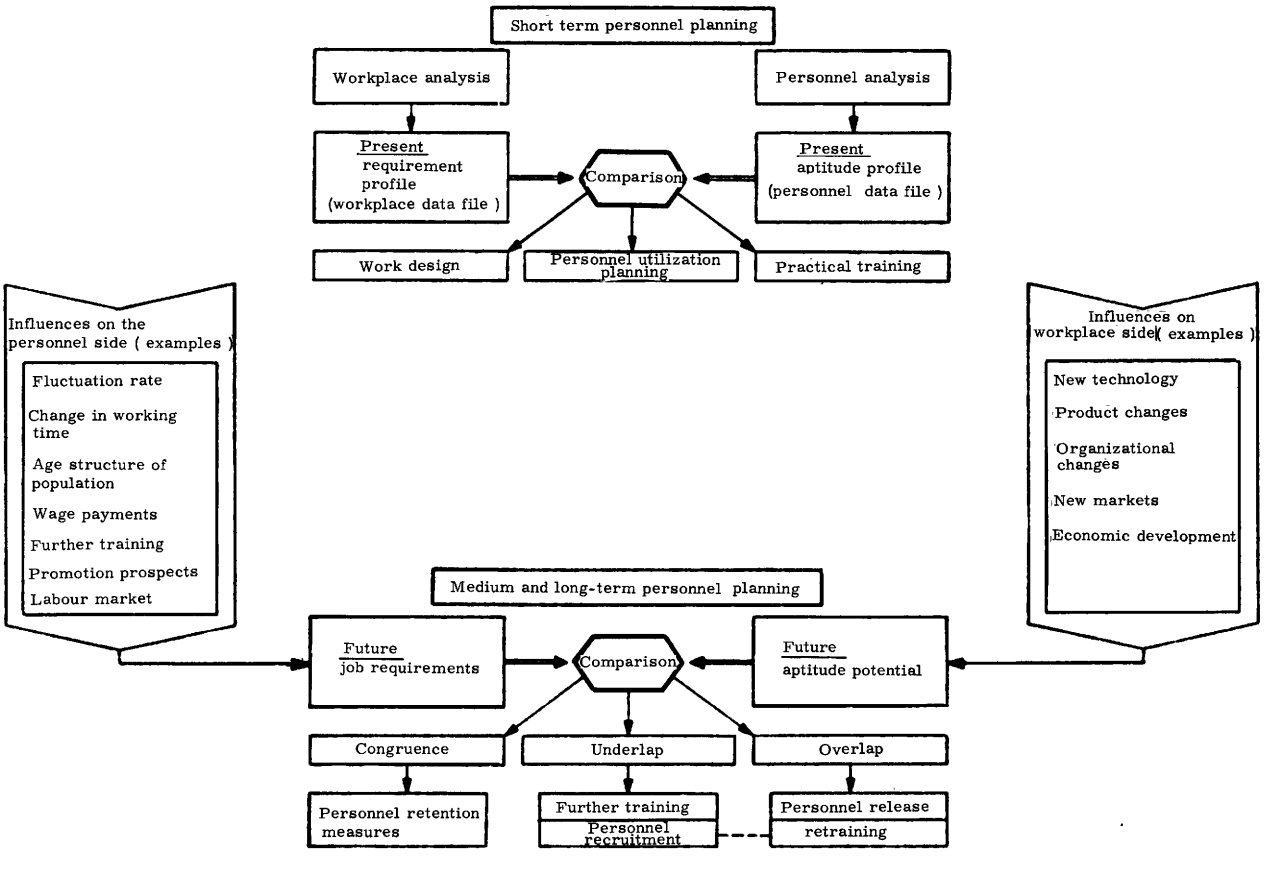

Fig. 21 : Diagram of a personnel planning model

the realization of the planned enterprise aims unless methods are designed in good time to clarify and quantify the developments and thus enable them to be influenced by effectively allowing for human interests in good time. It is therefore necessary - as already mentioned in the aims of the project - to develop a coupled model in which industrial personnel planning is no longer used as secondary to other forms of planning but as an equivalent area of planning which is fully integrated into enterprise planning.

The aim of a subsequent project would therefore be to compare the personnel requirements of an enterprise at a future time with the probable personnel establishment at that time, both qualitatively and quantitatively, in order to draw from the results of this comparison the necessary consequences both for personnel planning measures and for other sub-planning functions in the enterprise.

Many references were made in this report to the necessary relationship between longer term personnel planning and future-oriented ergonomic workplace design. While ergonomic workplace design has so far been concerned mainly with measures to be implemented in the short term it will have to do increasingly long term work in order to recognize in good time and influence the effects of technical and organizational change. In addition the transition from the previous mainly physiological approach to a more general physical-psychological view of the man-machine system means that the changes in the qualitative requirements and the comparable aptitudes of staff are known for long term planning measures. Only if ergonomics is not confined to the local improvement of existing technical and organizational systems but tries to influence the development of new socio-technical systems in general can it make a decisive contribution to the humanization of work.

In this sense the analysis method proposed here and the workplace and personnel information system designed in this project provide the basis for an enterprise policy corresponding to the aims of the enterprise and the interests of its staff and also lay the groundwork for a future-oriented ergonomic workplace design.

In conclusion, attention is drawn here to the publications of the Research Institute for Rationalization which were issued in connection with the project before this report was drawn up and which set out conceptual considerations and in some cases also interim results of the project :

G.A. KOCH; E. LUXEM; F.W. MEYER :
Die Arbeitsplatz-Analyse als Grundlage für eine zweckmässige Personaleinsatzplanung unter Berücksichtigung arbeitswissenschaftlicher Erkenntnisse
Arbeit und Leistung 26 (1972) 7, pages 185-188; 26 (1972) 8, pages 211-215; 26 (1972) 9, pages 242-245.

E. LUXEM :
Die funktionsorientierte Bestimmung von Tätigkeitsinhalten
Mitteilung aus der Arbeitsmarkt- und Berufsforschung 6 (1972) 3, pages 226-229.

F.W. MEYER :
Entwicklung einer rechnergestützten Methode zum Vergleich von Anforderungs- une Fähigkeitsprofilen
Ein Beitrag zum Aufbau von Arbeitsplatz- und Personal-Informationssystemen
Dissertation TH Aachen 1973.

F.W. MEYER; B. SCHNABEL :
Psychologische Testverfahren als Bestandteil eines Arbeitsplatz- und Personal-Informationssystems
Arbeit und Leistung 27 (1973) 1, pages 5-10.

R. HACKSTEIN; F.W. MEYER :
Die Abspeicherung und Auswertung von Arbeitsplatz- und Personaldaten mit Hilfe einer EDV-Anlage
Arbeit und Leistung 27 (1973) 5, pages 113-123.

G.A. KOCH :
Personalwesen und Personalplanung - ein Beitrag zur Definition
Arbeit und Leistung 27 (1973) 10, pages 266-268.

G.A. KOCH :
Struktur der Arbeitsplatz- und Personaldaten als notwendige Informationen für die Personalplanung
Arbeit und Leistung 27 (1973) 11, pages 300-306.

F.W. MEYER :
Aufbau von Arbeitsplatz- und Personal-Informationssystemen
Arbeit und Leistung 27 (1973) 11, pages 306-310.

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Items marked *) are only relevant to the catalogue of characteristics.

8. ANNEXES

ANNEX 8.1

CATALOGUE OF CHARACTERISTICS

TO ASSESS WORKPLACE REQUIREMENTS AND PERSONNEL APTITUDES

for skilled workers in the iron and steel industry

Main characteristic group	Characteristic group	Charact. number	Characteristic: Designation of characteristic	Number of alpha-numeric symbols: Workplace side	Personnel side
A General characteristics	A 1 General workplace data	1	Workplace No.	8	
		2	No. of identical workplaces	2	
		3	Designation of workplace	4	
		10	Activity categories	15	
		11	Enterprise and work sector	4	
		12	Inferior post	16	
		13	Superior post	3	
		14	Decision-making authority	1	
		17	Degree of movement	1	
		18	Training/experience	1	
	A 2 General personnel data	30	Individual number		6
		31	Name		30
		32	Nationality		2
		33	Address		48
		34	Family status		1
	A 3 General comparison characteristics	60	Sex	2	1
		61	Age	3	6
				Σ 60	Σ 94
B Knowledge characteristics	B 1 Schooling and technical training	100	Schooling	2	1
		105	Occupational category (training)	5	4
		106	Training level	2	1
	B 2 Occupational experience	110	Beginning of present activity		4
		111	Workplace number	18	40
		112	Enterprise and work sector	10	20
		113	Relevance of experience to sector	4	5
		114	Occupational category (experience)	10	20
		115	Level (experience)	4	5
		116	Duration	6	10
		118	And/or	1	
	B 3 Further and advanced training	170	Driving licences	9	6
		172	Other evidence of qualifications	15	10
		181 - 183	Knowledge of foreign languages	18	12
				Σ 104	Σ 138
C Physical characteristics	C 1 Muscular stress	200	Muscular effort	2	1
		201	Brief peak load	2	1
	C 2 Bodily posture	210	Bodily posture	4	4
	C 3 Vision and hearing	220	Visual acuity	2	1
		221	Spatial vision	2	1
		222	Colour vision	2	1
		226	Hearing power	2	1
	C 4 Function of members	230	Function of members	4	2
	C 5 Other physical characteristics	240	Alternating shift	1	1
		241	Fitness for wearing mask	2	1
		242	Freedom from giddiness	1	1
		243	Sudden occurrence of shock	1	1
				Σ 25	Σ 16
D Environmental factors	D 1 Climate, noise	300	Climate	2	1
		301	Noise	2	1
	D 2 Dirt, water, chemicals	310	Stress on skin	2	1
		311	Stress through dust... in the air	2	1
	D 3 Effects of mechanical vibrations	320	Whole body vibrations	2	1
		321	Hand/arm system vibrations	2	1
				Σ 12	Σ 6
E Psychological characteristics	E 1 Mental characteristics	400	Perceptive faculty	2	1
		401	Practical skill	2	1
		410	Technical understanding	2	1
		412	Powers of observation	2	1
		413	Mathematical skill	2	1
		414	Oral/written powers of expression	2	1
		417	Spatial perception	2	1
	E 2 Working and social behaviour	421	Quality of job performance	2	1
		422	Independence and initiative	2	1
		424	Resistance to stress and stamina	2	1
		430	Ability to cooperate	2	1
	E 3 Sensory-motor characteristics	440	Powers of reaction	2	1
		450	Manual skill	2	1
		451	Bodily skill	2	1
	E 4 Other psychological characteristics	460	Powers of concentration	2	1
		461	Endurance of monotony	2	1
		462	Capacity for individual work	2	1
				Σ 34	Σ 17
SUMMARY OF CHARACTERISTICS AND ALPHA-NUMERIC SYMBOLS REQUIRED				ΣΣ 235	ΣΣ 271

Priority code

Priority indexes are used to indicate the degree of importance of the individual requirements in the specified level for performance of the work functions.

Code digit	Grade definition	Examples
0	Characteristic has no importance for the workplace.	Absence of giddiness in a lathe worker
1	It would be desirable for the workplace occupant to meet the requirement characteristic at the specified level.	Knowledge of English for a fitter working abroad
2	The requirement characteristic should be met to perform the task at the workplace; in exceptional cases only it may be compensated by other characteristics.	Completed turner's apprenticeship at the "universal lathe" workplace
3	Absolutely essential for the requirement to be met at the specified level at the workplace; the workplace activity cannot be performed unless the characteristic is met at the specified level.	Grade II driving licence for a truck-driver

Characteristic No.	Characteristic description	Characteristic group	
1	Workplace number	A1	General workplace data

Definition and explanations	Notes on Workplace side	Notes on Personnel side
The workplace number must clearly indicate the workplace. The term workplace is taken to understand both a spatially fixed place of work and also the activity area of an individual. The workplace number should consist of a classifying part (matched with Characteristic 11) and an identifying part.	The workplace number should not if possible consist of more than eight digits (store space requirements)	No entry •

Characteristic No.	Characteristic description	Characteristic group	
2	Number of identical workplaces	A1	General workplace data

Definition and explanations	Notes on Workplace side	Notes on Personnel side
If several identical workplaces exist within a department, their theoretical number for a specific production - regardless of the present manning - is indicated here. These workplaces are given the same workplace number.	The occupation of the workplaces in the different shifts or as a function of the planned production quantity is indicated elsewhere, e.g. in the post occupation plan	No entry

Characteristic No.	Characteristic description	Characteristic group	
3	Designation of workplace	A1	General workplace data

Definition and explanations	Notes on Workplace side	Notes on Personnel side
The normal work designations for all workplaces should be catalogued in a code list. If necessary the designation can be printed out in clear text.	Indication of one to four digit code numbers depending on the enterprise	No entry

Example of the structure of a code for Characteristic 3

Foreman/ Group leader	VA	KF	Skilled worker		Trained worker		Assistant	
Continuous casting and finishing	011	111	First fitter	201	Roll stand controller	345	Yard worker	431
Pickling plant	043	143	Refractory-mason	261	Shear operator	352	Transport worker	456
.			.		.		.	
.			.		.		.	
.			.		.		.	

Characteristic No.	Characteristic description	Characteristic group	
10	Activity category	A1	General workplace data

Definition and explanations	Notes on Workplace side	Notes on Personnel side
The activity content is to be defined by indicating the functions to be performed at the individual workplace. In the following coding system the manifold activities of personnel in industry are classified in activity functions which are defined and explained by examples. Activity functions are operations performed by a specific individual in cooperation with other persons and/or machines, with a unified structure and directed at achievement of the industrial aim. By using a unified catagory schedule, common features of different workplaces can be recognized without reference to the given designation, the mechanical equipment, the form of organization or the technology applied; these features can be allowed for in personnel planning.	Indication of at most five activity functions per workplace	No entry

Code number	Designation and definition	Examples
	1. Manual working This function comprises all activities which bring about a change in an object by hand or by a hand-held tool (with or without outside energy source). The change may consist of shaping (e.g. pressing), parting (sawing), surface treatment by removal (filing, deburring or by application (painting, build-up welding, oiling, greasing). The joining of workpieces does not belong under the heading of manual working. Working is effected with at least two degrees of freedom.	
011	Non-shaping surface working by application Change in surface characteristics (appearance, smoothness, colour) by applying liquid, paste, priming compounds, etc.	Painting, priming, etching, oiling, greasing, lubricating, spraying.
012	Non-shaping surface working by removal Production of specified surfaces (e.g. defined by production process) or restoration of original surface condition.	Snagging, scraping, trimming, cleaning, brushing.
013	Shaping work Changing the surface by shaping by the addition or removal of material and changing the shape by forming and parting.	Build-up welding, filing, grinding, turning, hand-scarfing, driving, forging, bending, folding, torch-cutting, sawing, chiselling, engraving.
014	Other manual working (not specified under 011-013)	Stirring, kneading, mixing liquids, breaking open packages.
	2. Joining and connecting; taking apart This heading includes accurate joining or connecting of two or more (fixed) workpieces or taking apart without destruction.	

Code number	Designation and definition	Examples
021	Joining and connecting to a plan and/or specified position; detachable connections	
	This group of joining and connecting (assembly activity) includes the assembly of component units. The parts to be assembled are available, and the exact position is defined by an assembly plan and/or by a fixed position (limit stop, shape of the workpieces); the connections are detachable.	Screwing, inserting, shrink-fitting, pinning, keying, assembling dismantled units.
022	Joining and connecting to a plan and/or specified position; permanent connections	
	As function 021; the connection cannot, however, be broken without destruction.	Welding, bonding, soldering, riveting, nailing, joining by forming.
023	Setting mechanical operation	
	This heading includes assembly or connection activities necessary to bring machines into service or alter their operation.	Setting up machine tools; adjusting valve clearance; fitting attachments; adjusting; running-in machines; fitting tools and workpieces.
024	Dismantling, taking apart	
	This heading covers the dismantling of assemblies by detaching connections without destruction (screws, etc. see Function 021). It does not include torch-cutting, sawing, chiseling (see 013 shaping work).	Removal of (defective) parts; dismantling machines for transport.
025	Other joining and connecting	
	(not covered by 021-024).	
	3. Moving by physical effort	
	All activities involving the transport of goods by muscular effort (without powered vehicles). Unloading belongs to the sub-function in which the unloading operations terminate.	
031	Conveying to a fixed position	
	This heading includes the delivery and insertion of objects in a fixed position in clamping or holding devices, in suspension arrangements, etc.	Charging machine tools, transfer lines, presses, punches with holding devices, limit stops etc.; packing in mould containers; inserting metal parts in the clamping fixture of an automatic welding machine.
032	Conveying to an orderly position	
	Delivery and arrangement of objects in a position which is not fixed but is also not random.	Stowing objects in cartons on a loading surface; stacking objects; arranging material in a furnace; uniform covering of a melt with powder.
033	Conveying to a random position	
	Delivery and arrangement of objects in a position which is not fixed but is also not random.	Shoveling sand; throwing additives into a converter; throwing workpieces into a container; pouring liquid from a container into a mixer.
034	Conveying over long distances	
	This heading includes transport by physical effort over long distances (as necessary to carry out the other functions), including taking-up and depositing.	Carrying workpieces; pushing wheelbarrows, trucks; rolling barrels.
	4. Control	
	The term control denotes the influencing of an output parameter by setting an input parameter. An essential feature of control is the intervention of transmission elements of a mechanical, hydraulic, electrical or other nature. The	

Code number	Designation and definition	Examples
	information on the input parameter to be set can be obtained by the controller by an actual value - rated value comparison with the output parameter (regulating in the technical sense) or from some other source (programme, set sequence of input parameters). As both forms frequently occur jointly and cannot be easily separated, both belong under the control function.	
041	Controlling transport units by direct intervention The technical unit controlled is used to transport materials. The output parameter is influenced by analogy with the control movements.	Crane driving, driving electric trucks, fork lift trucks
042	Controlling transport units by indirect action The technical unit which is controlled is used to transport materials. Intervention is indirect.	Charging a pit furnace; introducing components onto an assembly line; controlling a conveyor unit in a high lift storage system
043	Controlling machines and equipment (non-transport) by direct action The controlled technical unit is not used for transport purposes. It is influenced by analogy with the control movement.	Controlling an upright drill by hand feed; controlling a steam quantity by means of a hand-operated valve; controlling a cutting speed by hand feed
044	Controlling machines and equipment (non-transport) by indirect action Unlike heading 043, machine functions or function sequences are automatic. The technical unit which is controlled is not used for transport purposes.	Selecting a programme sequence by push-button; switching in sub-units at the correct time; triggering automatic throat armour adjustments when charging a blast furnace
	5. Monitoring Monitoring is the observation of technical processes with a view to detecting irregularities and faults; these can be recognized by direct observation of the production process and mechanical installations or by observing indicator instruments; the reaction to the recognition of the irregularities and faults may consist in control or manual intervention by the utilizer; it may also consist in a notification to other staff. To characterize the type of intervention, the appropriate function is indicated.	
051	Observation of the production process and/or mechanical equipment	Monitoring an automatic packing machine, an automatic blast furnace charging system; monitoring multi-machine operations
052	Observing indicator instruments	Measurement centre activities
	6. Testing Determining the actual condition, by means of sense organs, with or without a number of instruments. Unlike monitoring, testing involves logical examination. Comparison with a rated value is contained in the test.	
061	Testing operating units by the sense organs This involves testing operating units exclusively by means of the sense organs (eyesight, hearing, feel) in order to determine whether the unit can still be used or why it is not functioning.	Testing a motor on the basis of its running noise; checking moulds for cracks; visual checks of the operational safety of cranes (damage to cables); checking vibrations or temperature of bearings; tracing faults (without testing instruments) when faults occur

Code number	Designation and definition	Examples
062	Testing operating units by the sense organs in conjunction with test instruments	
	This heading includes all test operations which can only be carried out with the aid of test instruments in addition to the use of the sense organs (e.g. measuring units, counters and weighing devices). This heading also covers the use of test aids to support the sense organs (magnifying glass, microscope, projector, test strips, listening devices, etc.). The operation of automatic test instruments without rated value-actual value comparison by human intervention does not fall under the testing function. The purpose of the test corresponds to that under 061.	Oil pressure test; measuring electrical cables and windings in the event of defects
063	Testing incoming materials, finished, partial or intermediate products by the sense organs	
	Testing exclusively by the sense organs in order to ascertain whether the material or product can be further processed, used or delivered.	Breaking test in pig iron production; visual paint checks; rolling cylindrical objects to test for warping
064	Testing incoming materials, finished parts or intermediate products by the sense organs in conjunction with test instruments	
	This heading includes test processes which, in addition to use of the sense organs, can only be carried out with the aid of test instruments in order to ascertain whether the materials or product can be processed, used or delivered. The operation of automatic test instruments without rated value-actual value comparison by human intervention does not belong under the test function.	Tolerance measurements on rolled plate; length measurement with a gauge; hardness test with test instrument; weight check with a balance
070	7. Recording	
	Recording data on material data supports	Recording entries and removal from store by type and quantity
080	8. Arranging	
	Dividing up a given quantity by set criteria and classifying.	Sorting out different products in finished product stores; sorting packets according to their destination for different intermediate stores on dispatch
090	9. Determining process data and working sequences	
	Defining technical and/or organizational implementation procedures.	Fixing work stages, process data, working means for a roughly defined task (independent lathe worker); determining the time sequence; allocating orders to machines and personnel; supervising materials; determining measures when faults occur
100	10. Leading staff	
	Obtaining a desired action from other staff by intervention, arguments and instructions.	Giving instructions, training, checking performance, motivating, compensating conflicting interests
110	11. Drawing	
	Presenting forms, dimensions, logical relationships and geometrical conditions in graphic form.	Preparing drawing board drawings, sequence plans, circuit diagrams; marking, sketching
120	12. Calculating	
	Using basic arithmetic, calculating according to a given programme.	Calculating store stocks in terms of entries and removals; adding quantities and rates; wage calculations

Characteristic No.	Characteristic description	Characteristic group	
11	Enterprise and work area	A1	General workplace data

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Indicating the area to which the workplace belongs in the general and detailed organizational structure of the enterprise. The classifying part of the workplace number should be used as far as possible.	An enterprise-specific code should be compiled according to the given enterprise structure.	No entry

Example of a code for the enterprise and work area

First digit :	Second digit :	Third digit :	Fourth digit:
(Code not specific to branch)	(Standard for iron and steel industry)	(Works sections-specific to enterprise)	(Works department)

- 1 Management
- 2 Commercial sector
- 3 Technical sector
- 4 Personnel sector
- 5 Other main departments

- 1 Technical management

Direct areas :

- 2 Pig-iron production
- 3 Steel production
- 4 Semi-finished and finished products production
  - 1 Oxygen converter steel works
    - 0 Technical management in converter steel works
    - 1 Converter operation
    - 2 Block casting
    - 3 Continuous casting
    - 4 Continuous casting finishing
    - 5 Yard operation
  - 2 Electric steel works
  - 3 SM steel works

Indirect areas :

- 5 Maintenance
- 6 Transport activities
- 7 Material management
- 8 Research and development

Characteristic No.	Characteristic description	Characteristic group	
12	Subordination	A1	General workplace data

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Indication of the workplace (workplace number) to which the analyzed workplace is directly subordinate. With separate technical and branch subordination the corresponding workplace numbers are indicated.	Separate storage of the enterprise organization chart would enable the position of the workplace in the organigramme to be shown if required.	No entry

Characteristic No.	Characteristic description	Characteristic group	
13	Supervision	A1	General Workplace data

Definition and explanations	Notes on Workplace side	Notes on Personnel side
The number of personnel a) directly, and b) indirectly subordinated to the analyzed workplace is shown. In addition the hierarchical stage (H) of the workplace is indicated according to an enterprise-internal code.	Grade according to grade definitions	No entry

Code number	Grade definition	Examples
	Number of directly or indirectly subordinated staff	
0	0	
1	1 - 3	
2	4 - 8	
3	9 - 15	
4	16 - 30	
5	31 - 60	
6	61 - 125	
7	126 - 250	
8	251 - 500	
9	> 500	
	Example of a hierarchy code	
7	Works manager	
6	Senior supervisor	
5	Supervisor	
4	Foreman	
3	Group leader	
2	Skilled worker	
1	Trained workers and auxiliary staff	

Characteristic No.	Characteristic description	Characteristic group	
14	Decision powers in respect of work performance	A1	General workplace data

Definition and explanations	Notes on Workplace side	Notes on Personnel side
The part of the work which is not previously planned or determined is taken as the basis for the level of decision-making powers, with reference to the work sequence and utilization factors.	Grading of characteristics by grade definitions and examples	No entry

Code number	Grade definition	Examples
0	Work sequence almost entirely planned in advance or corresponding instructions	Automatic machine operator, fitter's mate
1	Work sequence largely pre-planned or directives available for normal work	Switch operator, porter
2	Work sequence only partly or broadly pre-planned and/or requires minor decisions for the work of others	Qualified skilled worker, senior worker
3	Work sequence not pre-planned and contains specialized freedom of decision and/or organizational freedom and/or personnel freedom (utilization of personnel)	Supervisor, tracer for heavy steel casting

Characteristic No.	Characteristic description	Characteristic group	
17	Movement at workplace	A1	General workplace data

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Indicate to what extent the work is tied to a specific place.	Grading of characteristics by grade definitions and examples	No entry

Code number	Grade definition	Examples
	The activity is performed :	
0	in a department without movement	Lathe operator
1	in a department with movement	Crane driver
2	in a section of the enterprise or works	Quality controller
3	throughout the works	Messenger
4	sometimes also outside the works	Truck driver

Characteristic No.	Characteristic description	Characteristic group	
18	Training/Instruction	A1	General workplace data

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Indication of duration of training of a new staff member with sufficient existing qualifications and experience at a corresponding workplace (Familiarization with working environment, organization and informal contacts)	Grading of duration according to grade definitions	No entry

Code number	Grade definition	Examples
0	Short instruction (less than 1 week)	
1	Training for 1 to 6 weeks	
2	Training for 7 to 12 weeks	
3	Training for 3 to 6 months	
4	Training for more than 6 months	

Characteristic No.	Characteristic description	Characteristic group	
30	Personal number	A2	General personnel data

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Each staff member of the enterprise must be clearly identified by his personal number. Where possible the standard federal personal number will be used.	No entry	This number should be a serial number with 4-6 digits, depending on the enterprise size.

Characteristic No.	Characteristic description	Characteristic group	
31	Name	A2	General personnel data

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Surname, given name and any title in clear text	No entry	Maximum 30 symbols

Characteristic No.	Characteristic description	Characteristic group	
32	Nationality	A2	General personnel data

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Code list according to DEVO-DUVO [1]	No entry	

Code number	Nationality	Code number	Nationality
01	Germany	50	Egypt
02		51	Algeria
:		52	Ghana
:		53	Morocco
09		54	Nigeria
10	Albania	55	South Africa
11	Belgium	56	Other African countries
12	Bulgaria	:	
13	Denmark	:	
14	Finland	59	
15	France	60	Argentina
16	Greece	61	Brazil
17	Great Britain and Northern Ireland	62	Chile
18	Ireland	63	Canada
19	Iceland	64	Mexico
20	Italy	65	Peru
21	Yugoslavia	66	USA
22	Luxembourg	67	Other American countries
23	Netherlands	:	
24	Norway	:	
25	Austria	69	
26	Poland	70	China
27	Portugal	71	India
28	Rumania	72	Indonesia
29	Sweden	73	Iraq
30	Switzerland	74	Israel
31	Soviet Union	75	Japan
32	Spain	76	Jordan
33	Czechoslovakia	77	Pakistan
34	Turkey	78	Persia/Iran
35	Hungary	79	Other Asian countries
36	Other European countries	:	
:		88	
:		89	Australia, Pacific and other countries
49		:	
		:	
		98	
		99	Stateless/no declared nationality

1) DEVO : Regulation on data acquisition for social insurance purposes and for the federal labour establishment of 24.12.1972 (BGBL I page 2159)
DÜVO : Regulation on data transfer on data supports for mechanical processing in the area of social insurance and the federal labour establishment of 18.11.1972 (BGBL I page 2482)

Characteristic No.	Characteristic description	Characteristic group	
33	Address	A2	General personnel data

Definition and explanations	Notes on Workplace side	Personnel side
The address consists of :		
Postal code		4 digits
Place of residence	No entry	about 20 symbols
Street		about 20 symbols
House number		4 digits

Characteristic No.	Characteristic description	Characteristic group	
34	Family status	A2	General personnel data

Definition and explanations	Notes on Workplace side	Personnel side
Family status	No entry	Code number : 1 : single, widowed, divorced 2 : married

Characteristic No.	Characteristic description	Characteristic group	
60	Sex	A3	General comparison characteristics

Definition and explanations	Notes on Workplace side	Personnel side
Utilization of male and/or female employees	Use of male or female employees is : - 0 : excluded - 1 : possible - 2 : desirable - 3 : essential	Indication of a code number (male : 1, female : 2)

Characteristic No.	Characteristic description	Characteristic group	
61	Age	A3	General comparison characteristics

Definition and explanations	Notes on Workplace side	Personnel side
Age	Indication of minimum age (protected age, etc.) in years	Indication of date of birth

Characteristic No.	Characteristic description	Characteristic group	
100	Schooling	B1	School and technical education

Definition and explanations	Notes on Workplace side	Notes on Personnel side
The type of school and leaving examination are coded by a code number. Attendance at general schools is included here, while attendance at vocational training schools (technical schools, higher education establishments, etc.) is indicated under Characteristics 105 and 106.	Grading according to grade definitions and examples	In most firms these and the following characteristics can largely be obtained from the personnel files

Code number	Grade definition	Examples
		Equivalent to :
0	No schooling necessary/followed	
1	Special schools or schooling abroad below level of German secondary school leaving certificate	
2	Secondary school leaving	School leaving after ninth class of secondary or grammar school (upper fourth form)
3	Grammar school leaving certificate or technical school certificate	School leaving after tenth class (lower fifth form of grammar school)
4	Abitur	School leaving certificate after special school-leaving examination

Interrupted school studies are classified under the next lower stage

Characteristic No.	Characteristic description	Characteristic group	
105	Occupational category (training)	B1	Schooling and technical training

Definition and explanations	Notes of Workplace side	Notes of Personnel side
The occupational category indicates the nature of the required/ acquired specialized training. The coding is effected by indicating the index for the "occupational classification" of the federal statistics office, 1970 edition.	If this characteristic is irrelevant to the workplace, no indication is given here	If a staff member has been retrained, the new occupation is indicated here

Characteristic No.	Characteristic description	Characteristic group	
106	Level of education	B1	Schooling and technical education

Definition and explanations	Notes on Workplace side	Notes on Personnel side
The level of education indicates the level or duration of the necessary/acquired technical education.	If this characteristic is not relevant to the workplace, no indication is given here	Grading according to grade definitions and examples

Code number	Grade definition	Examples
0	Short instruction followed by immediate working activity	Washroom attendant, slag loader in basic slag grinding plant, blast furnace pig-carrier
1	Instruction by brief oral explanations and practical demonstration of activity so that the required operation and regulations to be observed as well as the work sequence, materials and operating means are known; followed by brief training and familiarization under supervision for up to three weeks, or longer in the case of foreigners.	Third melter - blast furnace, weighing operator, 50 ton scale, Second mould worker in SM steel works, sheet pickler
2	Training for a specific complex activity with degrees of freedom in work performance by a roughly preplanned, methodical learning process, generally broken down into individual steps with instruction given by a specially designated staff member so that events deviating from the normal working sequence can also be mastered. Generally the duration is more than three weeks, during which the trainee is initially only integrated temporarily into the work sequence.	Final cleaner for heavy steel castings, roll stand operator, blast furnace water attendant, continuous wire drawing line operator, 1st shear operator on sheet line
3	Specialized training : completed course of training for generally recognized occupations with less than 3 years training period. In the specified and to some extent already practised level : completion of the second or first training stage.	Drop forger, first smelter blast furnace, first smelter SM steel works
4	Apprenticeship : training for generally recognized occupation completed by an examination with three or 3 1/2 years training period. In the specified and already practised grade : completion of the third training stage. Equated with a skilled worker's certificate, completed by special authorization without apprenticeship or equivalent works-internal aptitude certificate.	Large workpiece moulder, large workpiece finishing turner, tool-maker, rolling mill electrician Senior smelter in an electric steel works
5	Foreman's qualification on the basis of works training and possibly examination	
6	Supervisor's examination as craft supervisor, industrial foreman, production supervisor or line supervisor. Equated with a fully equivalent works-internal aptitude certificate.	

		Characteristic group	
		B2	Professional experience

To characterize professional experience, two activities in which experience has been obtained may be indicated on the workplace side (the urgency of the requirement is indicated by priority numbers).

On the personnel side the acquired occupational experience will be expressed if possible by a total of five activities, namely the current job and the previous four jobs.

Characteristic designation	Characteristic number: Workplace side	Personnel side
Beginning of current activity		110
Workplace number	111, 121	111, 121, ..., 151
Enterprise and work sector	112, 122	112, 122, ..., 152
Relevance of experience to branch	113, 123	113, 123, ..., 153
Occupational category (experience)	114, 124	114, 124, ..., 154
Level	115, 125	115, 125, ..., 155
Duration	116, 126	116, 126, ..., 156
and/or	118	

Characteristic No.	Characteristic description	Characteristic group	
110	Beginning of present activity	B2	Professional experience

Definition and explanations	Notes on: Workplace side	Personnel side
Beginning of present activity	No entry	Indication of month/ year

Characteristic No.	Characteristic description	Characteristic group	
111	Workplace number	B2	Professional experience

Definition and explanations	Notes on: Workplace side	Personnel side
Workplace No. See characteristic 1	Indicate only when experience at a given workplace is necessary	

Characteristic No.	Characteristic description	Characteristic group	
112	Enterprise and work sector	B2	Professional experience

Definition and explanations	Notes on Workplace side	Notes on Personnel side
A uniform code number for the enterprise indicates the area in which the individual has or is gaining experience. Coding according to Characteristic 11.	The works area or department are often already indicated in the workplace number	

Characteristic No.	Characteristic description	Characteristic group	
113	Relevance of experience to branch	B2	Professional experience

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Determine whether the experience has been or is being gained in the enterprise itself, in another enterprise in the same sector, in another sector or in a different sector of industry. Grading according to grade definitions below.		

Code number	Grade definition	Examples
	Experience has been (or should have been) gained :	
0	In a separate branch/branch knowledge not important	
1	In the same branch	
2	In the same branch with similar production methods	
3	In the enterprise itself	

Characteristic No.	Characteristic description	Characteristic group	
114	Occupational category (experience)	B2	Professional experience

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Technical definition of experience according to the occupational classification of the federal office of statistics, 1970 edition (entry of a 4-digit code number). See also Characteristic 105.		

Characteristic No.	Characteristic description	Characteristic group	
115	Level (experience)	B2	Professional experience

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Qualification level at which experience was or should have been gained (e.g. as skilled worker or supervisor), graded according to code for Characteristic 106.		

Characteristic No.	Characteristic description	Characteristic group	
116	Duration	B2	Professional experience

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Number of months for which experience was or should have been gained at a workplace.		If the activity had been performed for more than 8 years, code number : 99

Characteristic No.	Characteristic description	Characteristic group	
118	And/or	B2	Professional experience

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Indicate whether experience in another activity is necessary in addition or as an alternative.	Indicate a code number: 1 = and 2 = or	No entry

Characteristic No.	Characteristic description	Characteristic group	
170	Driving licenses	B3	Advanced and further training

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Indicate class of driving licence and other driving certificates (locomotive driver's licence, crane driver's licence, etc.) according to 2-digit code (maximum 3 entries).		

Code number	Grade definition	Examples
	Example of a code for Characteristic 170	
	Driving licence according to StVO :	
01	Class 1	
02	Class 2	
03	Class 3	
04	Class 4	
05	Class 5	
	Special permits according to StVO, army, etc. :	
11	Taxi driver's permit	
12	Bus driver's licence	
13	Driving instructor's examination	
	Driving licences for rail vehicles	
21	Locomotive driver's permit	
22	Locomotive shunting permit	
23	Shunting permit	
24	Federal railways permit with 21 to 23	
	Driving licences, courses for cranes, etc.	
31	Basic crane driver's course	
32	Further crane driver's training	
33	Training in floor-controlled crane operation	
34	Casting trolley driver's course	
	Ground conveyor vehicles, excavators, etc.	
41	Electric or diesel truck driver's certificate	
42	Excavator driver's certificate	
43	Fork lift truck certificate	

Characteristic No.	Characteristic description	Characteristic group	
172	Other evidence of qualifications	B3	Further and advanced training

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Indicate a code number according to a 2-digit enterprise list of the necessary/acquired evidence of qualification. Show here for example : Foreman, industrial supervisor, welder, hydraulic, safety, personnel management courses.		

Characteristic No.	Characteristic description	Characteristic group	
181/182 183	Knowledge of foreign languages	B3	Further and advanced training

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Indicate what foreign languages required at the workplace or which languages staff have. Identification of foreign languages by nationality code (Characteristic 32).	Classification of oral and written knowledge according to grade definitions	For foreigners the native language is shown as the first foreign language

Code number	Grade definition		Examples
0	No knowledge :	Written/oral language knowledge not necessary/available.	
1	Little basic knowledge :	Language knowledge consists of only a few expressions, conversation impossible.	
2	Limited knowledge :	Written/oral expressions broken, barely sufficient for a conversation or letter.	
3	Satisfactory knowledge :	Language knowledge allows a conversation on everyday matters or translation of simple letters.	
4	Good knowledge :	Language mastered in writing/orally sufficiently well for a more exacting conversation to be possible or for more difficult texts to be translated.	
5	Very good knowledge :	Written/oral language knowledge equivalent to that of a native speaker.	

Characteristic No.	Characteristic description	Characteristic group	
200	Muscular effort	C1	Muscular stress

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Muscular effort designates the intensity and duration of the muscular effort. Grading is effected by measurement or estimation.	Workplaces graded by measuring the working pulse frequency and working calories per minute or on the basis of grade descriptions and guide values	Staff effort capacity graded by functional tests

Code number	Grade definition			Examples	
	Degree of muscular effort	Working calories wkcal/shift	Working pulse frequency	Working pulse frequency	Situation
1	Light muscular work	< 1000	< 20	~0	Rest
				~3 - 5	Sitting (without movement)
2	Medium muscular work	1000 - 1500	21 - 30	~10	Standing (without movement)
3	Heavy muscular work	> 1500	> 30	~15 - 20	Light office work, walking slowly, eating
				~60	Hammer forging work
				~75	Maximum strenuous work (well trained man for a maximum of one day)
				~100	Bathed in perspiration after 3 to 5 minutes
	Different code numbers may be obtained when workplaces are graded. The highest value is then decisive.			Working calories per shift	Situation
				~0	Rest
				~500	Light manual work in seated posture
				above~1000	Medium strenuous work
				above~1500	Strenuous work
				~2400	Upper limit of strenuous work

Characteristic No.	Characteristic description	Characteristic group	
201	Brief peak load	C1	Muscular effort

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Indicate maximum weight that must be held, lifted or carried briefly at the workplace.	Workplaces graded by weighting scale	Staff graded by force measurements (dynamometer) on the basis of a clinical assessment or force atlas 1)

Code number	Grade definition		Examples
1	Low load	< 15 kp	
2	Medium load	15 - 45 kp	
3	High load	> 45 kp	

1) Rohmert, W. : Maximum forces for male subjects in the arm and leg movement system, NRW Land Research report No. 1616, 1966

Characteristic No.	Characteristic description	Characteristic group	
210	Bodily posture	C2	Bodily posture

Definition and explanations	Notes on Workplace side	Notes on Personnel side
The bodily posture is coded by a 4-digit number : Code No. — Activity performed : 1. seated 2. standing 3. walking 4. in forced posture (e.g. kneeling, squatting, bending, working above head level, etc.)	Bodily posture identified by indicating priority figure (according to priority code) for each digit of code number. Example : Truck driver The activity is mainly performed in a seated posture but sometimes also in a forced posture (during inspection and repairs) Code Number : 3002	Doctor's indication of bodily postures which are acceptable for the individual. Acceptable : 1 Not acceptable : 0

Characteristic No.	Characteristic description	Characteristic group	
220	Visual acuity	C3	Sight and hearing

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Visual acuity [1]	Workplace grading according to grade descriptions and guide values	Visual acuity measurements by doctor

Code number	Grade definition	Visual acuity (separate indications for both eyes)	Maximum permissible correction on both eyes to achieve average or good visual acuity	Examples
1	Low visual acuity	less than 0.5/0.2 or 0.8/0		
2	Medium visual acuity	minimum value : 0.5/0.2 or 0.8/0	from + 2.0 sph + 1.0 cyl to - 3.0 sph - 1.0 cyl	
3	High visual acuity	minimum value : 1.0/0.8	from + 2.0 sph + 1.0 cyl to - 3.0 sph - 1.0 cyl	

1) H. Schmidtke, H. Schober : Sehanforderungen bei der Arbeit, Stuttgart 1967

Characteristic No.	Characteristic description	Characteristic group	
221	Spatial vision and unlimited field of vision	C3	Vision and hearing

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Spatial vision and unrestricted field of vision	Check whether spatial vision and unrestricted field of vision are necessary at the workplace (according to priority code)	Check the functional efficiency of both eyes Criterion met : Code No. 1 Criterion not met : Code No. 0

Characteristic No.	Characteristic description	Characteristic group	
222	Colour vision	C3	Vision and hearing

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Colour vision	Check whether colour vision is necessary (according to priority code)	Colour vision Yes : 1 No : 0

Characteristic No.	Characteristic description	Characteristic group	
226	Hearing	C3	Vision and hearing

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Check ability to hear spoken words and acoustic signals : The subject's hearing is good when the average hearing loss at the three frequencies of 500 Hz, 1000 Hz and 2000 Hz does not exceed a value of 25 dB [1] and if the hearing loss is less than 40 dB at 3000 Hz.	The hearing necessary at the workplace depends on the extent to which spoken words and acoustic signals may be concealed by background noise. Determine whether good hearing is necessary (according to priority code)	Screen test or audio-metric examination (initial or periodic examination) good hearing Yes : 1 No : 0

1) Plath, P. : Das Ton- und Sprachgehör bei Lärmschäden des Ohres, Stuttgart 1971, page 69

Characteristic No.	Characteristic description	Characteristic group	
230	Function of the limbs	C4	Function of the limbs

Definition and explanations	Notes on Workplace side	Notes on Personnel side
With particular reference to the employment of handicapped persons, ascertain whether full or only limited functional efficiency of the limbs is necessary at the workplace and present in the employee; structure according to : Function of upper limbs (arms and hands) Function of lower limbs (legs and feet)	Grade the necesary functional efficiency of the workplace according to grade descriptions and guide values	Ascertain the functional efficiency in the individual

Code number	Grade definition				Examples	
	Grade of functional efficiency	Degree of functional efficiency in percentage according to limb index for pension assessments [1]			Limbs upper	Limbs lower
1	Low functional efficiency	0	...	30 %	Loss of entire right arm (25 %)	Loss of entire leg (30 %)
2	Limited functional efficiency	>30	...	70 %	Loss of thumb, index and middle finger of right hand (60 %)	Loss of foot at ankle (65 %)
3	Slight impairment or full functional efficiency	>70	...	100 %	Loss of thumb and ring finger of right hand (75 %)	Loss of half a foot (75 %)

1) Federal welfare law, para. 30 and VV BVG, para 30

Characteristic No.	Characteristic description	Characteristic group	
240	Alternating shift	C5	Other physical characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Nature of working time or working time change according to following code : 1) Uniform working time during day 2) Alternating working time during day 3) Alternating working time between day and night	Workplaces graded according to adjacent grade descriptions	Indication of limitations with reference to code index 2 and 3 on the basis of medical examination

Characteristic No.	Characteristic description	Characteristic group	
241	Ability to wear respiratory mask	C5	Other physical characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Ability to wear respiratory mask at workplace. A distinction is made between half masks and heavy respiratory apparatus Code number : 0 no mask 1 half mask 2 heavy apparatus	Indicate type of mask required at workplace	Indicate limitation on the basis of medical examination

Characteristic No.	Characteristic description	Characteristic group	
242	Absence of giddiness	C5	Other physical characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Absence of giddiness	Indicate whether or not absence of giddiness is required (according to priority code)	Absence of giddiness : Yes : 1 No : 0

Characteristic No.	Characteristic description	Characteristic group	
243	Sudden occurrence of shock, pain or loss of consciousness	C5	Other physical characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Sudden occurrence of shock, pain or loss of consciousness	Ascertain whether these conditions are permissible or not at the workplace (according to priority code)	Occurrence of shock, pain, etc. is improbable : 1 possible : 0

Characteristic No.	Characteristic description	Characteristic group	
300	Climate	D1	Climate, noise

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Effective temperature and heat radiation are measured and grades separately.	Measurement of values at workplace and corresponding grading	Indication of grade which the individual can no longer tolerate by works doctor, bearing in mind possible work strenuousness grades

Code number	Grade definition						Examples
		Effective temperature °C [1] during			Thermal radiation kcal/m²h during		
		light | medium | heavy muscular work			light | medium | heavy muscular work		
	Climatic load	<1000	1000-1500	>1500	<1000	1000-1500	>1500
		Working wkcal/shift			Working wkcal/shift		
1	low	< 27	< 24	< 21	< 150	< 100	< 50
2	medium	27-30	24-27	21-24	150-250	100-150	50-100
3	high	> 30	> 27	> 24	> 250	> 150	> 100
	If different climate loads are found for effective temperature and thermal radiation, the highest value must be taken.						

1) Average values for 8-hour shift based on Grandjean, Hettinger, Müller, Wenzel (see the bibliography in Report section on Characteristic 300, page 64)

Characteristic No.	Characteristic description	Characteristic group	
301	Noise	D1	Climate, noise

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Measurement of sound pressure level in dBA [1] and grading by following code Code number — Sound pressure level 1 — < 70 dBA 2 — 70 - 90 dBA (limited speech communication possible) 3 — > 90 dBA (ear protection necessary)	Grading of workplace according to measured values	Indication by doctor of sound pressure level to which the individual must not be exposed

1) DIN 45630, Sheet 1, 1971 : Principles of sound measurement
DIN 45633, Sheet 1, 1970 : Precision sound level meters
DIN 45635, Sheet 1, 1972 : Noise measurements on machines

Characteristic No.	Characteristic description	Characteristic group	
310	Skin stress	D2	Dirt, water, chemicals, dust, gas and vapour

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Dust, water, chemicals	Indicate the extent to which resistance of the skin to dirt, water, chemicals, etc. is necessary at the workplace (according to priority code)	Indication by doctor whether the individual is allergic to dirt, water, etc. Yes : 0 No : 1

Characteristic No.	Characteristic description	Characteristic group	
311	Stress through dust, gas and vapour in the air	D2	Dirt, water, chemicals, dust, gas and vapour

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Code number : 0 : none 1 : troublesome 2 : harmful dust, gas, vapour in the air	Graded according to adjacent code	Indication by doctor whether the individual can be exposed to stress from dust, gas and vapour in the air. Yes : 1 No : 0

Characteristic No.	Characteristic description	Characteristic group	
320	Effect of mechanical vibrations on the whole body	D3	Effects of mechanical vibrations

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Code number : 0 : no effect 1 : brief effect (approx. 15 minutes per shift) 2 : continuous effect of mechanical vibrations		Check which effect stage is too high for the individual concerned

Characteristic No.	Characteristic description	Characteristic group	
321	Effects of mechanical vibrations on the hand/arm system	D3	Effects of mechanical vibrations

Definition and explanations	Notes on Workplace side	Notes on Personnel side
For code numbers see Characteristic 320		Check which effect stage is too high for the individual concerned

	Main characteristic group		
	Psychological characteristics		

The psychological characteristics are graded :

on the workplace side by estimation according to the grade definitions and the examples listed,

on the personnel side with the aid of psychological tests, exploration, etc. by the psychologist.

Characteristic No.	Characteristic description	Characteristic group	
400	Perceptive faculty	E1	Mental characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Speed and accuracy of familiarization with changed or new conditions and situations [1]		

Code number	Grade definition	Examples
0	The perceptive faculty is immaterial to the workplace as the working situation hardly changes.	(A) Mixer humidifying screw [2] (C) Assistant shear unit
1 (slight)	Changed conditions and situations which depart only slightly from known characteristics must be understood.	(A) Hot blast stove operator (B) 3rd smelter (convertor) (C) 1st acceptance tester (ultrasonic) (D) Lathe operator (mechanical repair workshop)
2 (medium)	Rapid understanding of frequently changing situations within a clear activity range or : Rapid understanding of detailed explanations and descriptions	(A) 1st smelter (blast furnace) (B) 1st manganese smelter (C) Foreman finishing line (D) Inspection fitter (continuous casting plant)
3 (high)	Rapid and correct understanding of new working situations and relationships or : Difficult or partly incomplete information must be fully grasped quickly	(A) Senior supervisor blast furnace (B) Crane load releaser (C) Shift foreman, finishing shop (D) Special electronics technician (communications technology)

1) Instructions for assessing and selecting future supervisors in the iron and steel industry, Düsseldorf 1971, page 8

2) (A) = Example from blast furnace sector
(B) = Example from oxygen convertor steel works
(C) = Example from plate rolling mill
(D) = Example from maintenance sector

Characteristic No.	Characteristic description	Characteristic group	
401	Practical skills	E1	Mental characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Ability to master a task with simple means and low effort		

Code number	Grade definition	Examples
0	Work situations in which practical skills are required seldom occur or all work stages and measures are defined in detail.	(A) Burden weigher (B) Melt book keeper (C) Card index keeper
1 (slight)	All working tasks can be completed with only slight changes in the normal method of work.	(A) Pig iron channel cleaner (B) Casting truck driver (C) Roll operator (first roll stand) (D) Refractory brick-layer
2 (aver-age)	Changed working situations must be mastered with appropriate means and methods.	(A) Burden shop foreman (B) 1st mixer (C) Foreman roll grinding shop (D) Works fitter (cold rolling mill)
3 (high)	Difficult tasks have to be carried out rationally under conditions which change considerably and often cannot be anticipated.	(C) Foreman electrician (profile rolling mill)

Characteristic No.	Characteristic description	Characteristic group	
410	Technical understanding	E1	Mental characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Technical processes and relationships shown in drawings or experienced during normal work must be grasped on the basis of independent examination and by general appraisal in order to take objectively appropriate measures in individual cases.		

Code number	Grade definition	Examples
0	Work situations in which technical understanding is required seldom occur.	(A) Soda weigher (B) Loading department foreman (C) 1st loader (D) Refractory brick-layer
1 (average)	The design and mode of operation of fairly small, clear plants must be understood to make sure of correct operation.	(A) Fuel oil attendant (B) Mould supervisor (C) Scrap shear assistant (D) Stone cutter (building operations)
2 (average)	The mode of operation of the plant units must be understood with reference to the special characteristics of raw, intermediate and final products and appropriate action taken Or : The causes of faults must be clearly recognized and measures taken to remedy them.	(A) Sinter plant foreman (B) 1st mixer (C) Roll grinding shop fitter (D) Profile works fitter
3 (high)	Symptoms (noises, vibrations, etc.) on complex technical installations must be understood so that appropriate measures can be taken to improve the mode of operation.	(B) Shift supervisor oxygen converter steel works (C) Shift supervisor finishing shop (D) Foreman electrician (oxygen converter steel works)

Characteristic No.	Characteristic description	Characteristic group	
412	Powers of observation	E1	Mental characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Recording, briefly retaining and reproducing conditions, texts and figures.		

Code number	Grade definition	Examples
0	Information storage and reproduction seldom required as detailed instructions are available for the work sequence.	(A) 3rd smelter (blast furnace) (B) Converter controller (C) Finishing shop assistant
1 (low)	The workplace requires storage and correct, complete reproduction of a few items of information.	(A) 1st water adjuster (blast furnace) (B) Test forger (C) Shearing machine operator (D) A/E welder (mechanical repair workshop)
2 (average)	Information of a specific kind for which memory aids (drawings, notes, etc.) may be needed, must be recorded in such a way that it can be reproduced when required correctly and/or without serious gaps.	(A) 1st smelter (blast furnace) (B) Loading foreman (C) Progress chaser (D) Industrial electrician (wide strip rolling mill)
3 (high)	Complex information (on conditions, texts, figures, etc.) must be recorded and retained in such a way that it can be reproduced when required without gaps or distortions.	(A) Shift supervisor melting plant (B) Shift supervisor oxygen converter steel works (C) Day supervisor technical operating centre (D) Foreman fitter (mechanical repair workshop)

Characteristic No.	Characteristic description	Characteristic group	
413	Mathematical skill	E1	Mental characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Noting and reproducing relationships expressed in terms of number and/or quantity [1]		

Code number	Grade definition	Examples
0	The relationships expressed in figures and/or quantities at the workplace are unimportant and there is little requirement for mathematical skill.	(A) Sinter worker dust control platform (B) 2nd smelter (converter) (C) Loader (D) Lance fitter oxygen converter steel works
1 (slight)	The requirement is confined to the reproduction of simple numerical and/or quantity relations for which explanations are available or may be requested.	(A) Sinter plant foreman (B) 1st mixer (C) Final controller finishing shop (D) Skilled worker energy/heating technology
2 (average)	Numerical and/or quantity relations of a simple nature have to be recorded or reproduced reliably.	(A) Burden weigher (B) Loading foreman (C) Sheet edge machine foreman (D) Foreman electrician (oxygen converter steel works)
3 (high)	Complicated numerical and/or quantity relations must be recorded or reproduced rapidly and accurately	(D) Specialized electronics technician (communication technology)

1) Social management publications of the Wirtschaftsvereinigung Eisen- und Stahlindustrie, Number 21 "Instructions for assessing and selecting future supervisors in the iron and steel industry", Düsseldorf 1971, page 8

Characteristic No.	Characteristic description	Characteristic group	
414	Oral/written powers of expression	E1	Mental characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Formulation of oral/written information in German		

Code number	Grade definition	Examples
0	Isolated workplace without formal communication; in the event of special occurrences questions may have to be answered.	(A) Soda conveyor (C) Scrap shear assistant
1 (slight)	Only simple information with low variation for which a small vocabulary is sufficient has to be given; verbal inaccuracy admissible.	(A) 2nd smelter blast furnace (B) 1st mixer (C) 1st finishing plant assistant (D) Electro-mechanic (electrical workshop)
2 (average)	The oral and written information sometimes contains complex but repetitive characteristics; a clear but not necessarily grammatically correct form of expression is required.	(A) Senior supervisor ore preparation (B) Day foreman continuous casting finishing shop (C) Quality control foreman (D) Industrial fitter foreman (blast furnace)
3 (high)	Oral and written information must be given clearly and concisely on widely varying and sometimes complex factors, bearing in mind the persons to whom it is addressed.	(C) Acceptance supervisor

Characteristic No.	Characteristic description	Characteristic group	
417	Spatial perception	E1	Mental characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Ability to gain a three-dimensional mental picture of objects shown in drawings or described or to represent three-dimensional objects on drawings (two-dimensional).		

Code number	Grade definition	Examples
0	The workplace requires no spatial perception as tasks of this kind hardly ever occur.	(A) 2nd smelter (blast furnace) (B) Scarfer continuous casting finishing shop (C) Annealer (continuous furnace) (D) Tool fitter
1 (slight)	Simple technical drawings have to be understood.	(A) Adjuster (burden shop) (B) Caster (casting pit - block casting) (C) Roll grinder (D) Industrial electrician (cold rolling mill)
2 (average)	Drawings of average to high complexity must be understood or sketches prepared of relatively simple objects.	(B) Mixer crane driver (D) Electric motor fitter (electrical workshop)
3 (high)	Highly complex technical drawings have to be read in such a way that the construction or component can be understood in all its details. Or : Complex technical objects must be presented in a clearly understandable manner in sketches.	(D) Inspection fitter (broad strip rolling mill)

Characteristic No.	Characteristic description	Characteristic group	
421	Quality of job performance	E2	Working and social behaviour

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Quality (accuracy, cleanness, completeness) of the working result. Care and order must also be taken into account.		

Code number	Grade definition	Examples
0	The quality of the job performance has practically no influence on the working result.	(A) Slag disposer (blast furnace) (B) 3rd plate man (casting pit) (C) Scrap shear assistant
1 (slight)	To achieve satisfactory working results careful performance of the task following instructions is of secondary importance.	(A) Sinter plant foreman (B) 3rd smelter (converter) (C) Straightening machine)
2 (average)	Work has to be performed carefully and/or in accordance with instructions at the workplace.	(A) Hot blast stove operator (B) Converter controller (C) Shear operator (main shear) (D) Skilled worker energy/heat engineering
3 (high)	All the tasks involved in the activity must be carried out extremely accurately and/or while observing stringent instructions.	(B) Mixer-crane driver (C) Acceptance supervisor (D) Specialized electrician (blast furnace)

Characteristic No.	Characteristic description	Characteristic group	
422	Independence and initiative	E2	Working and social behaviour

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Independence and sometimes spontaneous action necessary, using the available freedom of action.		

Code number	Grade definition	Examples
0	The working methods and sequence are defined in advance to such an extent that independent action is scarcely necessary.	(A) 3rd smelter (blast furnace) (B) Scarfer (continuous casting finishing shop) (C) Finishing shop assistant
1 (slight)	The working method and procedure are largely defined in advance or technically determined so that only minor independent action is necessary.	(A) Slag disposer (blast furnace) (B) Mixer-crane driver (C) Steel controller (annealing furnace)
2 (average)	Independent intervention in otherwise largely predetermined working sequences is sometimes necessary.	(A) Yard foreman (B) Loading foreman (C) Rolling grinding shop foreman (D) Industrial fitter (broad strip rolling mill)
3 (high)	The workplace requires a high level of independence. Own initiative necessary to perform the task.	(A) Shift supervisor ore preparation (B) Senior day shift machine foreman (crane) (C) Shift supervisor hot operations (D) Foreman refractory brick-layer

Characteristic No.	Characteristic description	Characteristic group	
424	Resistance to stress and stamina	E2	Working and social behaviour

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Readiness and strength of will to withstand high physical and/ or mental strain over a long period of time or to achieve aims despite considerable difficulties and setbacks.		

Code number	Grade definition	Examples
0	As the activity is relatively uniform at the workplace scarcely any requirements in respect of resistance to stress and stamina.	(A) Breaker worker (burden shop) (B) 3rd smelter (scrap weigher) (C) Machine operator (annealing furnace)
1 (slight)	Special strain due to peak loading occurs in exceptional cases; assistants are then generally available.	(A) 3rd smelter (blast furnace) (B) Foreman continuous casting finishing shop (C) Card index supervisor (D) Inspection/maintenance fitter (cold rolling mill)
2 (average)	Frequent peak loads occur during the working sequence and have to be handled without a deterioration in working quality.	(A) Pig iron channel cleaner (B) 1st mixer (C) Material attendant (final check) (D) Shift leader industrial fitter (oxygen converter steel works)
3 (high)	High stresses lasting for a long time must be withstood without a deterioration in working results, or the workplace conditions result in load peaks which have to be overcome without a deterioration in working quality.	(D) Electronics mechanic (telecommunications technology)

Characteristic No.	Characteristic description	Characteristic group	
430	Ability to cooperate	E2	Working and social behaviour

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Ability and willingness to cooperate adequately with others.		

Code number	Grade definition	Examples
0	Isolated workplace requiring only occasional and mainly informal contact with other persons.	(A) Hot blast stove operator (B) Lime tipper and conveyor belt attendant (C) Pit furnace operator
1 (slight)	The activity requires the establishment and maintenance of loose contacts of a technical and material kind with others.	(A) Fuel oil attendant (blast furnace) (B) Converter controller (C) Steel controller (annealing furnace) (D) Lathe operator (mechanical workshop blast furnace)
2 (average)	Cooperation is necessary with mutual assistance within a changing, limited circle of persons.	(A) 1st senior smelter (blast furnace) (B) Foreman casting pit (C) Foreman slabbing mill store (D) Electrician (oxygen converter steel works)
3 (high)	Cooperation is necessary in a group with a structured interrelationship; group members perform their tasks in close contact with each other. [1]	(A) Yard foreman (B) Oxygen converter steel works senior supervisor (D) Foreman fitter (broad strip rolling mill)

1) Popitz, H. inter alia : Technik and Industriearbeit, Tübingen 1957

Characteristic No.	Characteristic description	Characteristic group	
440	Powers of reaction	E3	Sensory-motor characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Ability to react quickly and reliably to requirements with sensory-motor responses.		

Code number	Grade definition	Examples
0	No ability extending beyond basic reactions is required at the workplace.	(B) Loading foreman (C) Quality control foreman (D) Electric motor fitter (electrical workshop)
1 (slight)	Specified reactions which are easy to learn required as a matter of routine to precisely defined requirements (e.g. specific signals).	(A) Burden shop breaker operator (B) 1st smelter (converter) (C) Scrap shear assistant (D) Industrial fitter (cold rolling mill)
2 (average)	Correct responses are required simultaneously or in rapid sequence to one or more requirements which may occur simultaneously	(A) 2nd senior smelter (blast furnace) (B) Converter controller (C) Machine operator (trimming shear) (D) Skilled worker in special branch (energy/heat engineering)
3 (high)	One or more responses, the sequence and interruption of which are not precisely defined, are required simultaneously or in rapid succession to one or more requirements with differing occurrence probabilities or under complex conditions (time pressure, unusual situations, dangers, etc.)	(B) Casting crane driver

Characteristic No.	Characteristic description	Characteristic group	
450	Manual skill	E3	Sensory-motor characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Ability to complete arm, hand and finger movements for a specific purpose with the correct force and for the correct time. [1]		

Code number	Grade definition	Examples
0	The simple manual operations required at the workplace place hardly any requirements on manual skill.	(A) Pig iron channel cleaner (C) Acceptance supervisor
1 (slight)	The workplace requires an ability to roughly coordinate finger, hand and arm movements with the correct force and for the requisite length of time.	(A) Mixer humidifying screw (B) Mould cleaner (C) Roll operator (1st roll stand) (D) Building works supervisor
2 (average)	Extensive control of finger, hand and arm movements is required to complete the tasks.	(A) Fuel oil attendant (blast furnace) (B) 1st mixer operator (C) Materials attendant (end shear) (D) Vacuum plant fitter (oxygen converter steel works)
3 (high)	Very close tolerances have to be observed. This can only be done by precisely determined control with the correct force and coordination of finger, hand and arm movements.	(B) Trainee scarfer continuous casting finishing shop (D) Specialized tele-communications fitter

1) Based on social management publications of the Wirtschaftsvereinigung Eisen- und Stahlindustrie, analytical evaluation of employee activities, Düsseldorf 1971, page 16

Characteristic No.	Characteristic description	Characteristic group	
451	Bodily skill	E3	Sensory-motor characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Ability to complete head, torso and leg movements appropriately with the correct force and at the correct time. [1]		

Code number	Grade definition	Examples
0	The workplace requires hardly any bodily skill	(A) Hot blast stove operator (B) Melt book keeper (C) Roll grinding shop foreman
1 (slight)	The workplace requires rough coordination of bodily posture and movements of the limbs.	(A) Adjuster (burden shop) (B) Roof-pit unloader (C) Controller (finishing roll stand) (D) Electrical winder (electrical workshop)
2 (average)	Considerable control of the bodily movements is required to perform the tasks.	(A) Pig iron channel cleaner (B) Plate mason (block casting) (C) Crane driver (D) Oxygen converter steel works fitter
3 (high)	Precisely defined control and coordination with the correct force and at the correct time of the bodily posture and limb movements is required to complete working tasks and/or for adaptation to specific working situations which require high physical skill.	(B) 1st mixer

1) Based on social management publications of the Wirtschaftsvereinigung Eisen- und Stahlindustrie, analytical evaluation of employee activities, Düsseldorf 1971, page 16.

Characteristic No.	Characteristic description	Characteristic group	
460	Powers of concentration	E4	Other psychological characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Ability to devote full attention to a working task over an extensive period of time without being diverted by extraneous influences.		

Code number	Grade definition	Examples
0	Tasks which never require complete application.	(A) Soda conveyer (B) Roof-pit unloader (C) Loading assistant
1 (slight)	Complete application generally for a short period is only seldom required at the workplace.	(A) 1st smelter (blast furnace) (B) Manganese smelter (C) Materials attendant (end shear) (D) Inspection fitter (continuous casting plant)
2 (average)	The proportion of activities which require complete application generally only for a short period alternates with other activities of much the same duration.	(A) Burden weigher (B) Converter controller (C) Controller (3rd roll stand) (D) Specialized electrician (cold rolling mill)
3 (high)	Complete attention constantly necessary and generally only interrupted by agreed pauses.	(B) Stripper crane driver

Characteristic No.	Characteristic description	Characteristic group	
461	Endurance of monotony	E4	Other psychological characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Degree of resistance to the physical and psychological consequences of the constant repitition of uniform, simple to medium-difficult work with restricted area of observation.		

Code number	Grade definition	Examples
0	The activity offers sufficient variety so that no monotony occurs.	(A) Senior smelter (blast furnace) (B) Additive preparer (C) Finishing shop foreman
1 (slight)	Resistance to the effects of repititive medium-difficult activities extending over lengthy periods.	(A) Burden weigher (B) Caster (casting pit-block casting) (C) Roll grinder (D) Stone cutter (building operations)
2 (average)	Resistance to the effects of constant repetition of simple to medium-difficult activities.	(A) Adjuster (burden shop) (B) Lagging remover (C) Final checker (finishing shop)
3 (high)	Resistance to the effects of short, simple activities in rapid succession over a long period.	

Characteristic No.	Characteristic description	Characteristic group	
462	Capacity for individual work	E4	Other psychological characteristics

Definition and explanations	Notes on Workplace side	Notes on Personnel side
Ability to perform work over extended periods of time without or with only very slight visual and/or verbal contact with others.		

Code number	Grade definition	Examples
0	The workplace normally offers the possibility of formal and informal contacts.	(A) Sinter plant foreman (B) 1st smelter (converter) (C) 1st finishing shop assistant (D) Refractory brick-layer
1 (slight)	Workplace close to other workplaces but with no need for direct cooperation. Possibilities of informal contact.	(A) Burden remover (B) Lime tipper and conveyor belt attendant (C) Roll grinding shop fitter (D) Inspection/maintenance fitter (cold rolling mill)
2 (average)	Isolated workplace at which cooperation with others is necessary and can be effected by means of signals or brief conversation on intercom.	(A) Hot blast stove operator (B) Test forger (C) Edging shear operator (D) Special telecommunications fitter
3 (high)	The workplace is completely isolated in space and there are only slight possibilities for formal and/or informal contacts.	

ANNEX 8.2

D A T A R E C O R D I N G F O R M S

Surname, given name

Personal No.

Career and education

1. Present activity

Workplace designations	since

2. Previous activities

a) In own enterprise

Activity designation	Work sector (e.g. burden shop, blast furnace mechanical maintenance)	from	to

b) In other enterprises

Activity designation	Branch (e.g. metal processing industry, building industry)	from	to

3. Occupational training

Trained profession (e.g. electrician, fitter)	from	to	Nature of examination (e.g. skilled worker's examination, apprenticeship)

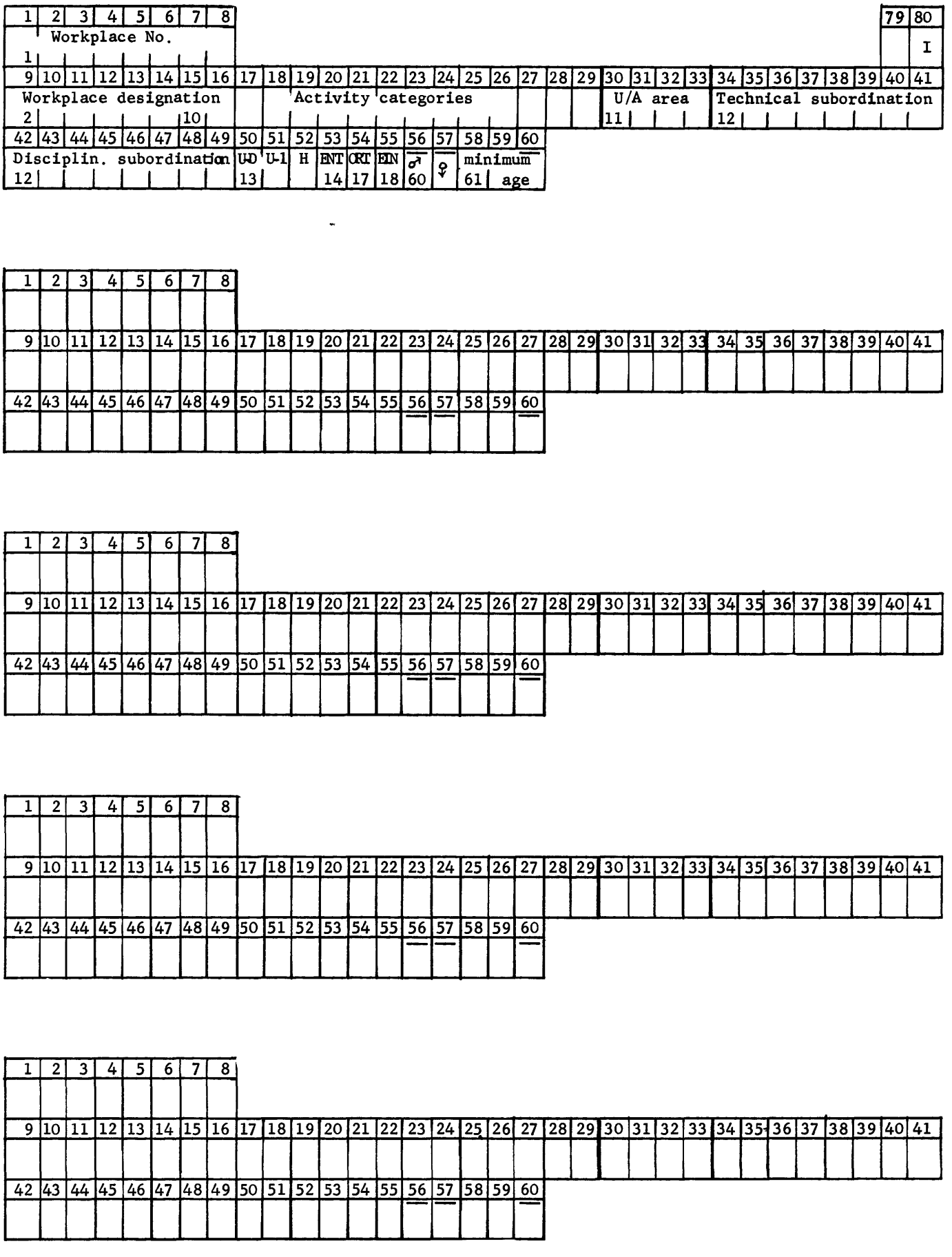
4. Schooling

Type of school (e.g. primary or secondary school, grammar school)	from	to	Type of leaving certificate (e.g. 8th class)

5. Courses within the enterprise and outside and other further training measures (e.g. technical evening school, supervisors' course, driving licences, knowledge of foreign languages, Refa certificates)

Annex 8.2.1 : Form for data on education and career

W O R K P L A C E D A T A S H E E T



Annex 8.2.2 : Basic structure of workplace data sheets to record workplace data

WORKPLACE DATA SHEETS

1	2	3	4	5	6	7	8																							79	80
1		Workplace No.																													2
9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
School		Occupat. cat. A					Level A		Workplace number								U/A area				Bra		Occup. cat. E					Level E		Duration		U/O
100		105					106	111									112				113		114					115		116		118
								43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66		
								121	Workplace number							122	U/A	area		Bra 123		Occup. cat. E 124					Level E 125		Duration 126				

1	2	3	4	5	6	7	8																							79	80
1		Workplace No.																													3
9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38		
		Driving licences										Other qualifications												1.FR.S.		M.K.		S.K.			
170									172															181							
39	40	41	42	43	44	45	46	47	48	49	50																				
2.FR.S.		M.K.		S.K.		3.FR.S.		M.K.		S.K.																					
182						183																									

1	2	3	4	5	6	7	8																							79	80
1		Workplace No.																													4
9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	
Muscular strain		Bodily posture					Eye-sight		F	Hear	Upper Lower limbs					WS	Mask		S		Climate		Noise		SWC	Gas			GK		H/A	
200		201		210			220	221	222	226	230					240	241		242	243	300		301		310			320		321		

1	2	3	4	5	6	7	8																							79	80
1		Workplace No.																													5
9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Per-ception		Pract. skills		Techn. underst.		Obser-vation		Mathem. skill		Or. Wr.	expr.	Spat. percept		Qual. j.perf.		Inde-pend.		Stamina		Cont.		Re-act.		Manual skill		Bodily skill		Concen-tration		Mo-notony		Ind. work	
400		401		410		412		413		414	415	417		421		422		424		430		440		450		451		460		461		462	

Annex 8.2.3 : Screen blocks of workplace data sheets Nos. 2 - 5

PERSONNEL DATA SHEETS

1	2	3	4	5	6																									79	80
Personal No.																															1
30																															
7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
									Surname, given name, title																						Nation.	
31																															32	
40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63									
	PLZ											Address																				
33				34																												

1	2	3	4	5	6																									79	80
Personal No.																															2
30																															
7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
									Street												Number			FS	♀♂	Date of birth						Sch
35																								37	60	61						100
40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66						
Occup.class				Lev.	Beginning activity						Workplace No.						U/A-area				Bra.	Occupation class E			Lev.							
105				106	110				111								112				113	114			115							

1	2	3	4	5	6														79	80
Personal No.																				3
30																				
7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
Workplace No.								U/A Sector				Bra.	Occupation class E				Lev.	Du-ration		
121								122				123	124				125	126		
27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	
Workplace No.								U/A Sector				Bra.	Occupation class E				Lev.	Du-ration		
131								132				133	134				135	136		

1	2	3	4	5	6														79	80
Personal No.																				4
30																				
7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
Workplace No.								U/A Sector				Bra.	Occupation class E				Lev.	Du-ration		
141								142				143	144				145	146		
27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	
Workplace No.								U/A Sector				Bra.	Occupation class E				Lev.	Du-ration		
151								152				153	154				155	156		

1	2	3	4	5	6																							79	80
Personal No.																													5
30																													
7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32				
Driving licences												Other qualifications																	
170						172																							
33	34	35	36	37	38	39	40	41	42	43	44																		
1.FS		MK	SK	2.FS		MK	SK	3.FS		MK	SK																		
181				182				183																					

Annex 8.2.4 : Screen blocks of personnel data sheets numbers 1 - 5

PERSONNEL DATA SHEET No. 6

(Findings of medical examination*))

Personal No.

1. Muscular effort (C. No. 200)	2. Brief load peaks (C. No. 201)	3. Bodily posture (C. No. 210)	4. Visual acuity (C. No. 220)	5. Spatial vision (C. No. 221)	6. Colour vision (C. No. 222)
☐ 1000-1500 | 21-30 ☐ > 1500 | 30 Wcal/shift | WPF	☐ 15-45 kp ☐ > 45 kp	☐ Mainly sitting ☐ Mainly standing ☐ Mainly walking ☐ Often forced posture	☐ Medium ☐ High	☐	☐

7. Hearing power (C. No. 226)	8. Function of upper members (C. No. 230)	9. Function of lower members (C. No. 230)	10. Alternating shift (C. No. 240)	11. Fitness for wearing mask (C. No. 241)	12. Freedom for giddiness (C. No. 242)
☐	☐ > 30- 70% ☐ > 70-100%	☐ > 30- 70% ☐ > 70-100%	☐ Changing hours during day ☐ Day and night shifts	☐ Half mask ☐ Heavy breathing apparatus	☐

13. Freedom from shock, etc. (C. No. 243)	14. Climate (C. No. 300)	15. Noise (C. No. 301)	16. Skin stress (C. No. 310)	17. Respiratory organs (C. No. 311)	18. Insensitivity to vibrations (C. Nos. 320/321)
☐	☐ Medium ☐ High	☐ Medium (70-90 dBA) ☐ High (ear plugs)	☐	☐	☐ Short-term effect ☐ Long-term effect ☐ Hand-arm system

*) Limitations in respect of stress capacity, compatibility, etc. are indicated by crosses

Annex 8.2.5 : Personnel data sheet No. 6

PUNCHING FORM FOR PERSONNEL

DATA SHEET No. 6

| 1 | 2 | 3 | 4 | 5 | 6 | | |

PERSONNEL DATA FORM No. 7

(Findings of psychological examination)

Personal No.

Characteristic		Psychological job requirements to be excluded		
No.	Designation	low	medium	high
400	Perceptive faculty			
401	Practical skills			
410	Technical understanding			
412	Powers of observation			
413	Mathematical skill			
414	Oral/written powers of expression			
417	Spatial perception			
421	Quality of job performance			
422	Independence and initiative			
424	Resistance to stress and stamina			
430	Ability to cooperate			
440	Powers of reaction			
450	Manual skill			
451	Bodily skill			
460	Powers of concentration			
461	Endurance of monotony			
462	Capacity før individual work			

Annex 8.2.7 : Personnel data sheet No. 7

PUNCHING FORM

FOR PERSONNEL DATA FORM No. 7

1	2	3	4	5	6

0	1	2	
			7
			8
			9
			10
			11
			12
			13
			14
			15
			16
			17
			18
			19
			20
			21
			22
			23

Note :

a) The crosses in boxes 7 - 23 indicate - by their position - which of the grade figures 0, 1 or 2 listed above should be punched in punched card columns 7 - 23

b) A 3 is generally punched in the uncrossed columns

	79
7	80

Annex 8.2.8 : Punching form for personnel data form No. 7

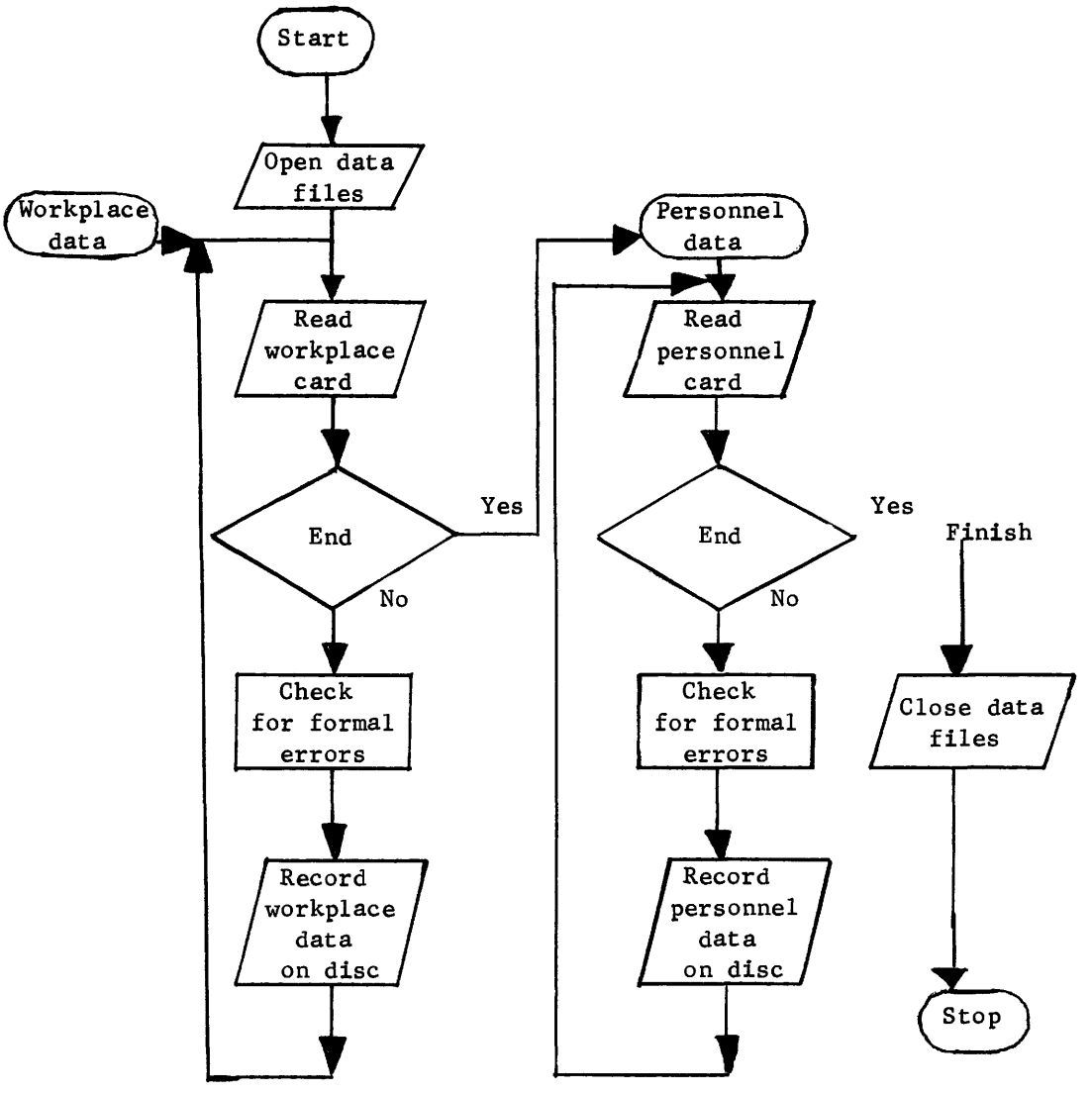
ANNEX 8.3

F L O W C H A R T S

Annex 8.3.1 : Simplified flow chart of storage programme API 100

Summary :

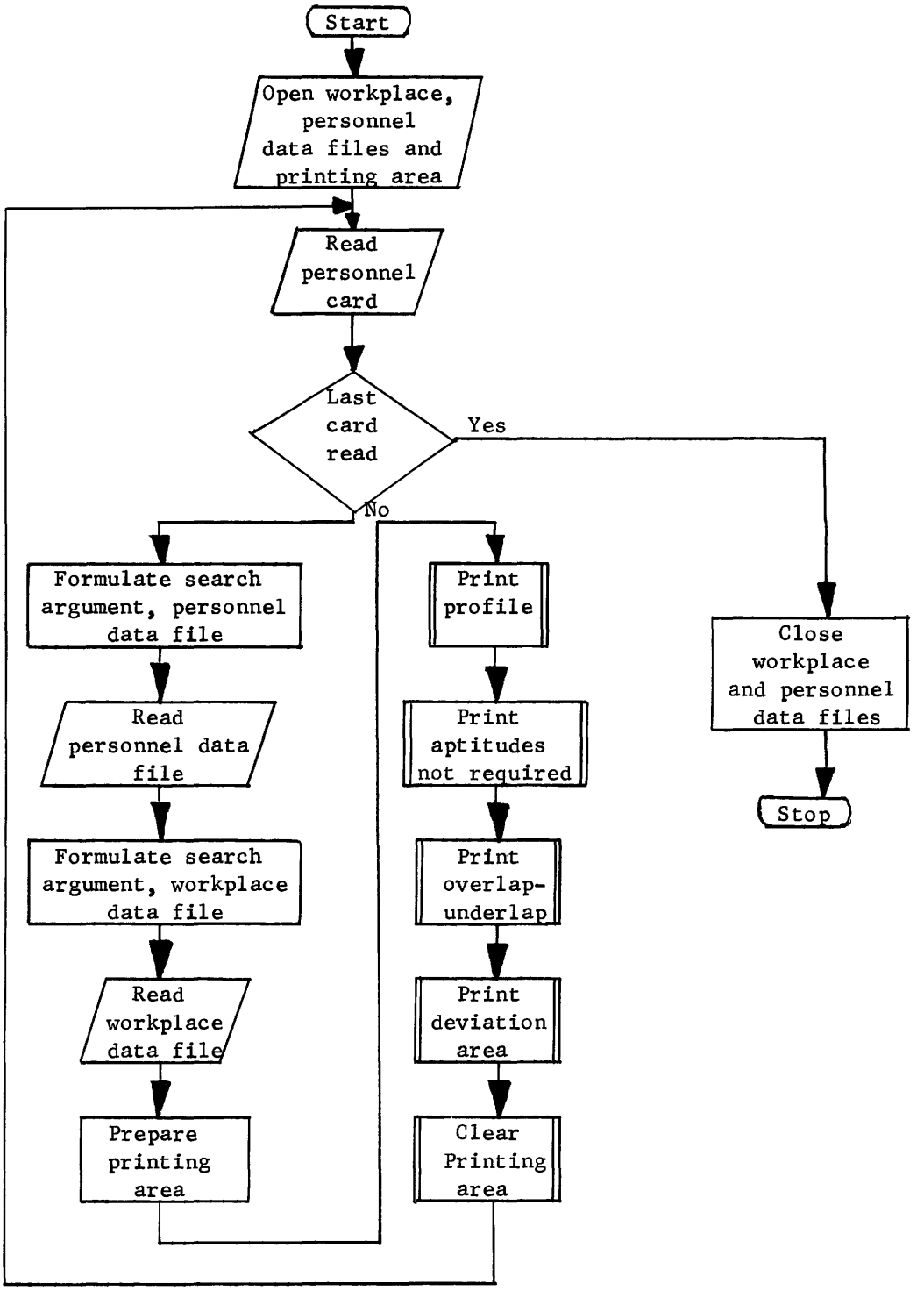
The programme reads-in workplace and personnel data from punched cards and stores them sequentially on magnetic disc.



Annex 8.3.2 : Simplified flow chart of evaluation programme API 400

Summary :

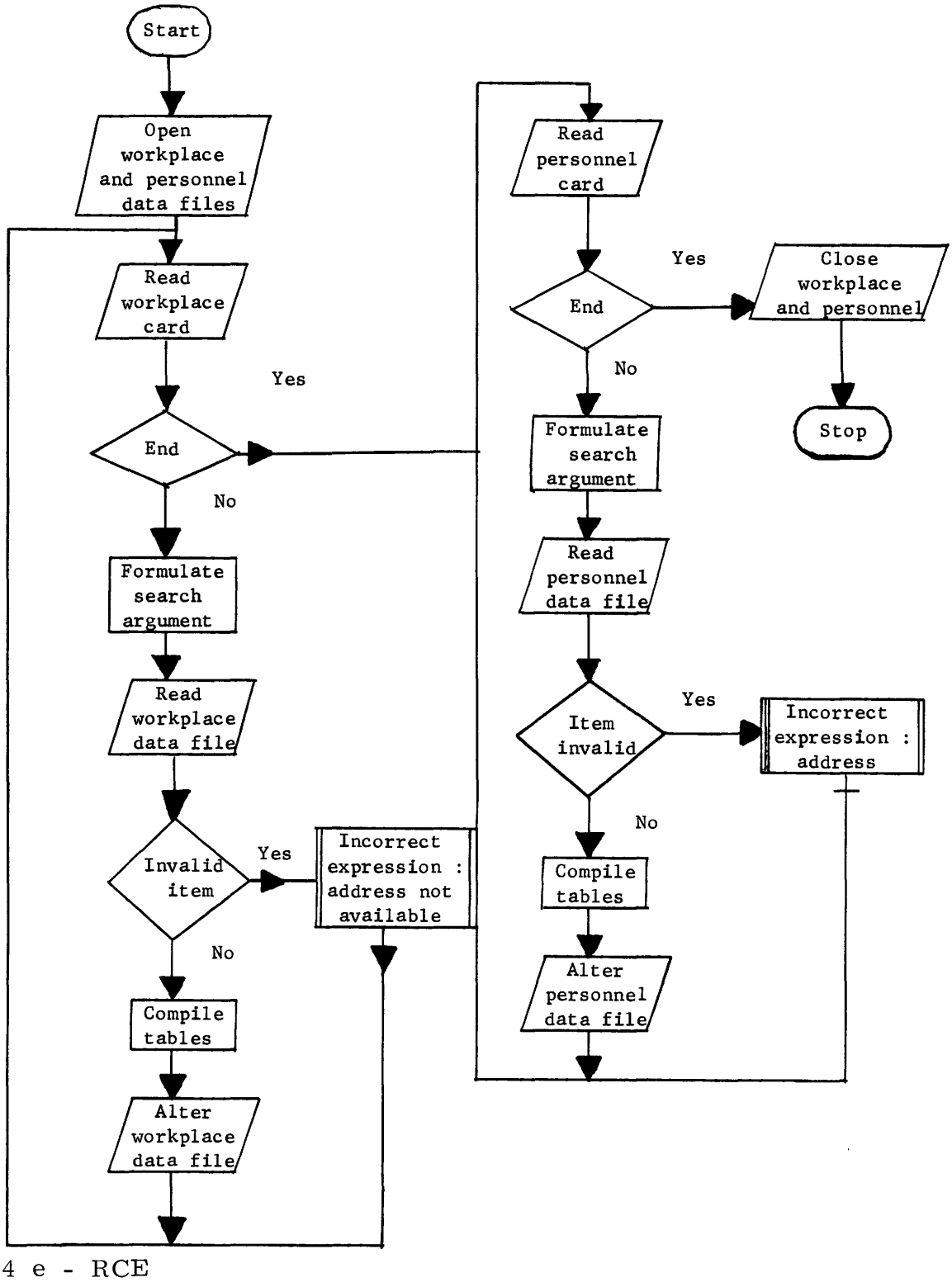
The programme effects the profile comparison and additional evaluations; underlapping and overlapping of the individual characteristics are determined as well as the total deviation index.



Annex 8.3.3 : Simplified flow diagram of modification programme API 600

Summary :

The programme is used to correct and update the workplace and personnel data files.



ANNEX 8.4

LISTING OF WORKPLACE AND PERSONNEL DATA FOR EXAMPLE 1

A. GENERAL WORKPLACE DATA

M11 WORK PLACE Nc : 1504500 | M21 No OF ID WORKPLACES 02 | M31 DESIGN OF WORKPLACE 3450

M10 ACTIVITY CATEGORIES 042, 000, 000, 000, 000 | M111 ENT AND WORK SECT 3421 | M121 INFERIOR POST 1504010

M12 INSUFFI : 1504099 | M131 SUPERIOR POST 00 | M141 DECIS MAKING AUTH. 2 | M151 REPEAT WORK 0

M16 TEAMWORK 3 | M171 DEGREE OF MVT 0 | M601 SEX 1 MALE 3 FEMALE 0 | M611 AGE 18 PR13

B. KNOWLEDGE CHARACTERISTICS

M100 SCHOOLING 2 PR12 | M110-111 SPECIAL FORM OCCUP. CAT 1920 PR13 LEV. 2 PR13

M121-128 1, ACTIVITY U/A 3421 PR13 PROF 1921 PR13 LEV. 2 PR13 BR-K 3 PR13 AP-BEZ PR AP-NR D 06 PR12 V/01

M131-137 2. ACTIVITY U/A 0000 PR PROF PR LEV. PR BR-K PR AP-BEZ PR AP-NR DURATION PR

M170 DRIV LICENCE PR , PR , PR | M171 REFA-LICENCE PR , PR , PR , PR , PR

M172 W. REFAEHIG. PR , PR , PR , PR , PR | M180-181 GERMAN BY FOREIGNERS ORAL. 2 PR12 WRIT 2 PR13

M182-184 1. FOR LANG PR ORAL. PR WRIT PR | M185-187 2 FOR LANG PR ORAL. PR WRIT PR

M188-190 3. FOR LANG PR ORAL. PR WRIT PR

C. PHYSICAL CHARACTERISTICS L E

M200 MUSCULAR EFFORT 3 | M201 BRIEF PEAK LOAD 0 PR13 | M210 BOD. POST 01000 PR13 PR10 | M220 VISUAL ACUITY 1 PR13

M221 SPATIAL VISION 2 | M222 COULOUR VISION 2 | M226 HEARING POWER 3 | M230 FUNCT OF MEMBERS PR13

M230 FUNCTOF MEMBERS 3 | M240 ALTERNATING 3 | M241 FIT OF WEARING MASK PR10 | M242-243 GIDDNESS 2 SHOCK 3

D. ENVIRONMENTAL INFLUENCES

M300 CLIMATE 1 PR13 | M301 NOISE 1 PR13 | M310 STRESS ON SKIN 1 | M311 STRESS DUST 0

M320 BODY VIBR. 0 PR10 | M321 HAND/ARM VIBR 0 PR10

E. PSYCHOLOGICAL CHARACTERISTICS

M400 PERCEP FAC 2 PR12 | M401 PRACTICAL SKILL 1 PR12 | M410 TECH. UNDERST 2 PR13 | M411 PO OF ORGANIS. 0 PR10

M412 PO OF OBSERV. 2 PR12 | M413 MATH. SKILL 1 PR13 | M414 ORAL EXPR. 1 PR13 | M415 WRIT PO OF EXP 1 PR13

M416 APPR OF DIST. 1 PR13 | M417 SPATIAL PERC 0 PR10 | M420 WORK RYTHM 2 PR12 | M421 QUAL OF PERFORM. 2 PR12

M422 INDEP. AND INIT. 2 PR12 | M423 RESPONSIBILITY 2 PR13 | M424 RESIST. OF STRESS 2 PR13 | M425 PO OF CHANGE 1 PR13

M430 ABIL TO COOP. 2 PR13 | M431 PO OF LEADING 0 PR10 | M440 PO OF REACT. 2 PR13 | M450 MANUAL SKILL 2 PR12

M451 BODILY SKILL 1 PR13 | M460 PO OF CONCENT. 2 PR13 | M461 ENDUR. OF MONOT 1 PR13 | M462 IND. WORK 1 PR13

Annexe 8.4.1. : Listing of data for " Final Roll stand controller " workplace

A. GENERAL PERSONNEL DATA

M30: INDIVIDUAL NUMBER : 1 2 9 7 3 1 M31: NAME CHR. NE. TITEL: PERSON OF COMPARISON 1

M32: NATIONALITY: 01 M33-36: ADDRESS : 100 AACHEN , X . STREET 1000

M37: TAX CATEGORY M60: GE SEX : 1 M61: BIRTH DATE 01 01 39

B. INFORMATION CHARACTERISTICS

M100: SCHOOLING : 2 M110.111: SPECIAL FORM: OCCUP CAT.: 1920 LEVEL : 2

M120.125: 1: ACTIVITY: BEG: 09.73 U/A: 3421 PROF.: 1920 LEVEL: BRANCH C.: DESIGN OF W. P: 3450 WORK PLACE No 504050

M131-137: 2. ACTIVITY: UNT.-ARB.-BER.: PROF.: LEVEL: BRANCH C.: DESIGN OF W. P: WORK PLACE No: DURATION:

M141-147: 3. ACTIVITY: UNT.-ARB.-BER.: PROF.: LEVEL: BRANCH C.: DESIGN OF W P: WORK PLACE No: DURATION:

M151-157: 4. ACTIVITY: UNT.-ARB.-BER.: PROF.: LEVEL: BRANCH C.: DESIGN OF W. P: WORKPLACE No: DURATION:

M161-167: 5. ACTIVITY: UNT.-ARB.-BER.: PROF.: NIVEAU: BRANCH C.: DESIGN OF W. P: WORKPLACE No: DURATION:

M170: DRIV. LIC.: 03 31 M171: REFA-LIC : , , , , M172: OTHER EVID. OF QUAL. , , , ,

M173: S.: 2: , 3:

M180.181: GERMAN: M: 2 S: 2 M182-184: 1.FR.S: 04 M: 3 S: 2 M185-187: 2.FR.S: M: S: M188-190: 3.FR.S: M: S:

C. PHYSICAL CHARACTERISTICS

M200: MUSCULAR EFFORT 2 M201: BRIEF PEAK LOAD 1 M210: BODILY POSTURE 1101 M220: VISUAL AC: 1

M221: SPATIAL VISION : 0 M222: COLOUR VISION 1 M226: HEARING POWER 1 M230: FUNCT. OF MEMBERS 2

M230: FUNCT. OF MEMBERS 2 M240: ALTERNATING SHIFT 3 M241: FIT. OF WEARING MASK 1 M242.243: GIDDNESS SHOCK 1

D. ENVIRONMENTAL INFLUENCES

M300: CLIMATE 2 M301: NOISE 1 M310: SKIN EFFECT 1 M311: BREATHING AIR 0

M320: BODY VIBR. 0 M321: HAND/ARM VIBR. 0

E. PSYCHICAL CHARACTERISTICS

M400: PERCEPT FAC : 1 M401: PRATIC SKILL .: 2 M410: TECHN. UNDERST. 1 M411: PO OF ORGANIS.: 1

M412: PO OF OBSERV: 1 M413: MATH. SKILL 1 M414: ORAL EXP. 1 M415: WRITTEN EXP.: 1

M416: APPREC. OF DIST 1 M417: SPATIAL PERC. 1 M420: WORK RYTHM. 2 M421: QUALI OF JOB. : 1

M422: INDEP. AND INIT. 3 M423: RESPONSABILITY 1 M424: RESIST STRESS 1 M425: PO OF CHANGE: 2

M430: ABILITY TO COOP. 1 M431: PO OF LEADING: 2 M440: PO OF REACT.: 2 M450: MANUAL SKILL 1

M451: BODILY SKILL: 1 M460: PO OF CONCENT.: 1 M461: ENDUR. OF MONOT. 1 M462: IND WORK IT: 1

Annexe 8.4.2. : Listing of personnel data for comparison subject 1

A. GENERAL PERSONNEL DATA

M30: INDIVIDUAL NUMBER : 1 2 9 7 3 2 M31:NAME:CHR N TITLE: PERSON OF COMPARISON 2

M32: NATIONALITY 01 M33-36: ADDRESS : 100 AACHEN , Y • STREET 0027

M37:TAX CATEGORY2 M60:G SEX : 1 M61 BIRTH DATE : 27 04 38

B. KNOWLEDGE CHARACTERISTICS

M100:SCHOOLING : 2 M110.111:SPECIAL FORM:OCCUP CAT': 1922 LEVEL: 2

M120-126:1, ACTIVITY :BEG: 11.73 U/A: 3421 PROF.: 1921 LEVEL: 2 KNOW. BR : 3 DESIGN. OF W.P. 3450 WORKPLACE No:150.050

M131-137:2. ACTIVITY :UNT.-ARB.-BER.: PROF.: LEVEL: KNOW. BR : DESIGN. OF W.P. WORKPLACE No: DURATION:

M141-147:3, ACTIVITY :UNT.-ARB.-BER.: PROF.: LEVEL: KNOW. BR : DESIGN. OF WP WORKPLACE No: DURATION:

M151-157:4. ACTIVITY :UNT.-ARB.-BER.: PROF.: LEVEL: KNOW. BR : DESIGN. OF WP WORKPLACE No: DURATION:

M161-167:5. ACTVITY :UNT.-ARB.-BER.: PROF.: LEVEL: KNOW. BR: DESIGN. OF WP WORKPLACE No: DURATION:

M170:F DRIV. LIC : 03, 33, M171:R REFA-LIC. : , , , , M172:WE OTHER EVID. OF QUALIF. : , , , ,

M173:S.W:M: , 2: , 3:

M180.181:GERMAN:M: 2 S: 2 M182-184:11.FR.S: 05 M: 2 S: 1 M185-187:12.FR.S: M: S: M188-190:13.FR.S: M: S:

C. PHYSICAL CHARACTERISTICS

M200:MUSCULAR EFFORT 2 M201:K:BRIEF PEAK LOAD:NG: 2 M210: BODILY POSTURE 1111 M220: VISUAL ACUITY : 1

M221:SPATIAL VISION : 1 M222: COLOUR VISION : 0 M226: HEARING POWER 1 M230: FUNCT OF MEMBERS : 2

M230:FUNCT. OF MEMBERS 1 M240: ALTERNATING SHIFT 3 M241:FIT.OF WEARING MASK 2 M242.243 GIDDINESS SHOCK: 1

D ENVIRONNENTAL INFLUENCES

M300: CLIMATE 3 M301: NOISE 2 M310: STRESS ON SKIN : 1 M311: STRESS. DUST 1

M320: BODY VIBR. : 0 M321: HAND/ARM VIBR. 0

E. PSYCHICAL CHARACTERISTICS

M4CC: PERCEPT. FAC. : 2 M401:PRACTIC SKILL : 1 M410:TECHN.UNDERST : 2 M411: PO OF ORGANIS.: 1

M412 PO OF OBSERV. : 2 M413:MATH. SKILL: 1 M414: ORAL EXPR. 1 M415:WRITTEN EXPR. 2

M416 APPREC. OF DIST.1 M417:SPATIAL PERC. 1 M420:WORK RYTHM : 2 M421: QUALI. OF JOB : 3

M422:INDER AND INIT. 1 M423: RESPONSABILITY: 2 M424:RESIST.OF STRESS 1 M425: PO. OF CHANGE : 2

M430 ABILITY TO COOP. 2 M431: PO. OF LEADING: 0 M440: PO OF REACT. : 2 M450: MANUAL SKILL 2

M451:BODILY SKILL : 1 M460:PO. OF CONCENT. : 2 M461 ENDUR OF MONOT 0 M462: IND. WORK : 1

Annexe 8.4.3. Listing of personnel data for comparison subject 2

A. GENERAL PERSONNEL DATA

M30: INDIVIDUAL NUMBER : 1 2 9 7 3 3 M31 NAME CHR. N, TITEL PERSON OF COMPARISON 3

M32: NATIONALITY: 01 M33-36: ADDRESS: 100 AACHEN , Z . STREET 1002

M37: TAX CAT. : 4 M60 GE SEX : 1 M61: BIRTH DATE: 01 02 37

B. INFORMATION CHARACTERISTICS

M100: SCHOOLING : 2 M110-111: SPECIAL FORM. : 2740 LEVEL: 4

M120-126 1: ACTIVITY: BEG: 05.70 U/A: 3421 PROF.: 2740 LEVEL: 4 BRANCH C. 3 DESIGN. Of W. P 017 WORKPLACE No: 50 0500

M131-137 2: ACTIVITY: UNT.-ARB.-BER.: PROF.: LEVEL: BRANCH C.: DESIGN. OF W. P.: WORKPLACE No: DURATION:

M141-147 3: ACTIVITY: UNT.-ARB.-BER.: PROF.: LEVEL: BRANCH C.: DESIGN. OF W. P.: WORKPLACE No: DURATION:

M151-157 4: ACTIVITY: UNT.-ARB.-BER.: PROF.: LEVEL: BRANCH C.: DESIGN. Of W. P: WORKPLACE No: DURATION:

M161-167 5: ACTIVITY: UNT.-ARB.-BER.: PROF.: LEVEL: BRANCH C.: DESIGN. OF W. P.: WORKPLACE No: DURATION:

M170: DRIV. LIC.: 03, M171: REFA-LIC. : , , , , M172: OTHER EVID. OF QUAL. : 58, , , ,

M173: S.WB M: , 2: , 3:

M180-181: GERMAN: M: 3 S: 3 M182-184 1.FR.S: M: S: M185-187 2.FR.S: M: S: M188-190 3.FR.S: M: S:

C. PHYSICAL CHARACTERISTICS

M200: MUSCULAR EFFORT 2 M201: BRIEF PEAK LOAD : 2 M210: BOD. POST. 1110 M220: VISUAL AC : 2

M221: SPATIAL VISION : 1 M222: COLOUR VISION : 1 M226: HEARING POWER 1 M230: FUNCT. OF MEMBERS: 2

M230: FUNCT. OF MEMBERS 2 M240: ALTERNATING SHIFT 3 M241: FIT. OF WEARING MASK 2 M242-243: GIDDNESS SHOCK: 0

D. ENVIRONMENTAL INFLUENCES

M300: CLIMATE 1 M301: NOISE 1 M310: SKIN EFFECT : 1 M311: STRESS. DUST 1

M320: BODY VIBR. : 1 M321 HAND/ARM VIBR. 1

E. PSYCHICAL CHARACTERISTICS

M400: PERCEPT. FAC. 2 M401: PRACT. SKILL.: 3 M410: TECHN. UNDERST 3 M411: PO. OF ORGANIS. 1

M412: PO. OF. OBSERV. 2 M413: MATH. SKILL 2 M414: ORAL EXP : 2 M415: WRITTEN EXP : 2

M416 APPREC. OF DIST. 1 M417: SPATIAL PERC. 2 M420: WORK RYTHM 2 M421: QUAL. OF JOB ET: 2

M422: INDEP. AND INIT. 2 M423: RESPONSIBILITY 2 M424: RESIST. STRESS 3 M425: PO. OF CHANGE: 2

M430 ABILITY TO COOP. 2 M431: PO. OF LEADING: 2 M440: PO. OF REACT. 2 M450: MANUAL SKILL 2

M451: BODILY SKILL 0 M460 PO. OF CONCENT. 3 M461: END. OF MONOT. 2 M462: IND. WORK T: 2

Annex 8.4.4 : LISTING OF PERSONNEL DATA FOR COMPARISON SUBJECT 3

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